SCIENTIFIC AMERICAN SUPPLEMENT No. 433

Scientific American Supplement, Vol. XVII., No. 433.
Scientific American, established 1845.

NEW YORK, APRIL 19, 1884.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

THE FRENCH SCIENTIFIC STATION AT CAPE HORN.

IN 1875 Lieutenant Weyprecht of the Austrian navy called the attention of scientific men to the desirability of having an organized and continual system of hourly meteorological and magnetic observations around the poles. In 1879 the first conference of what was termed the International Polar Congress was held at Hamburg. Delegates from eight nations were present—Germany, Austria, Denmark, France, Holland, Norway, Russia, and Sweden.

The congress then settled upon a programme whose features were: 1. To establish general principles and fixed laws in regard to the pressure of the atmosphere, the distribution and variation of temperature, atmospheric currents, climatic characteristics. 2. To assist the prediction of the course and occurrence of storms. 3. To assist the study of the disturbances of the magnetic elements and their relations to the auroral light and sun spots. 4. To study the distribution of the magnetic force and its secular and other changes. 5. To study the distribution of heat and submarine currents in the polar regions. 6. To obtain certain dimensions in accord with recent methods. Finally, to collect observations and specimens in the domain of zoology, botany, geology, etc.

The representatives of the various nations had several conferences later, and by the 1st of May, 1881, there were sufficient subscribers to justify the establishment of eight Arctic stations.

France entered actively in this work later, and its first expedition was to Orange Bay and Cape Horn, under the surveillance and direction of the Academy of Sciences, Paris, and responsible to the Secretary of the Navy. On the 6th of September, 1882, this scientific corps established itself in Orange Bay, near Cape Horn, and energetically began its serious labors, and by October 22 the greater part of their preliminary preparations was completed, comprising the erection of a magnetic observatory, an astronomic observatory, a room for the determination of the carbonic anhydride of the air, another for the sea register, and a bridge 92 feet long, photographic laboratory, barometer room, and buildings for the men, food, and appurtenances, together with a laboratory of natural history.

In short, in spite of persistent rains and the difficulties of the situation, from September 8 to October 22 they erected an establishment of which the different parts, fastened, as it were, to the flank of a steep hill, covered 450 square meters (4,823 square feet), and rested upon 200 wooden piles.

From September 26, 1882, to September 1, 1883, night and day uninterruptedly, a watch was kept, in which the officers took part, so that the observations might be regularly made and recorded. Every four hours a series of direct magnetic and meteorological observations was made, from hour to hour meteorological notes were taken, the rise and fall of the sea recorded, and these were frequently multiplied by observations every quarter of an hour; the longitude and latitude were exactly determined, a number of additions to the catalogue of the fixed stars for the southern heavens made, and numerous specimens in natural history collected.

The apparatus employed by the expedition for the registration of the magnetic elements was devised by M. Mascart, by which the variations of the three elements are inscribed upon a sheet of paper covered with gelatine bromide, inclination, vertical and horizontal components, with a certainty which is shown by the 330 diurnal curves brought back from the Cape.

The register proper is composed of a clock and a photographic frame which descends its entire length in twenty-four hours, thus causing the sensitized paper to pass behind a horizontal window upon which falls the light reflected by the mirrors of the magnetic instruments. One of these mirrors is fixed, and gives a line of reference; the other is attached to the magnetic bar, whose slightest movements it reproduces upon the sensitized paper. The moments when direct observations were taken were carefully recorded. The magnetic *pavilion* was made of wood and copper, placed at about fifty-three feet from the dwellings or camp, near the sea, against a wooded hill which shaded it completely; the interior was covered with felt upon all its sides, in order to avoid as much as possible the varying temperatures.

The diurnal amplitude of the declination increased uniformly from the time of their arrival in September up to December, when it obtained its maximum of 7' 40", then diminished to June, when it is no more than 2' 20"; from this it increased up to the day of departure. The maximum declination takes place toward 1 P.M., the minimum at 8:50 A.M. The night maxima and minima are not clearly shown except in the southern winter.

The mean diurnal curve brings into prominence the constant diminution of the declination and the much greater importance of the perturbations during the summer months. These means, combined with the 300 absolute determinations, give 4' as the annual change of the declination.

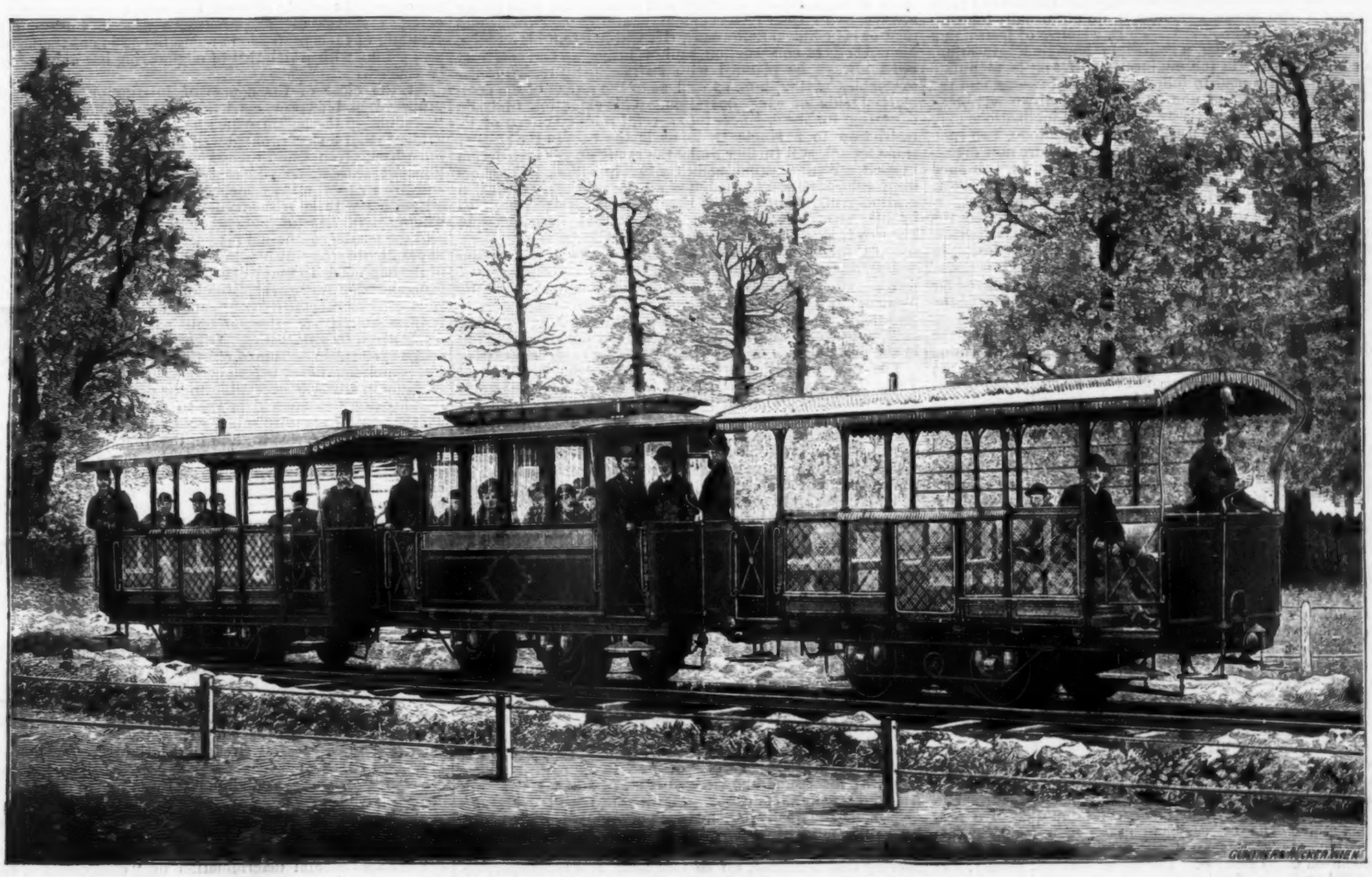
M. Mascart's apparatus proved to be wonderfully useful in recording the rapid and slight perturbations of the magnet. Comparisons between the magnetic and atmospheric perturbations gave no result. There was, however, little stormy weather and no auroral displays. This latter phenomenon, according to the English missionaries, is rarely observed in Tierra del Fuego.

The electrometer used at the Cape was founded upon the principle developed by Sir William Thomson. The atmospheric electricity is gathered up by means of a thin thread of water, which flows from a large brass reservoir furnished with a metallic tube 6·5 feet long. The reservoir is placed upon glass supports isolated by sulphuric acid, and is connected to the electrometer by a thread of metal which enters a glass vessel containing sulphuric acid; into the same vessel enters a platinum wire coming from the aluminum needle. Only 3,000 observations were given by the photographic register, due to the fact that the instruments were not fully protected against constant wet and cold.

Besides these observations direct observations of the magnetometer were made, and the absolute determination of the elements of terrestrial magnetism attempted.

On the 17th of November, 1882, a severe magnetic disturbance occurred, lasting from 12 M. until 3 P.M., which in three hours changed the declination 49'. The same perturbation was felt in Europe, and the comparison of the observations in the two hemispheres will prove instructive.

THE ELECTRIC RAILWAY AT VIENNA.



THE ELECTRIC RAILWAY AT VIENNA.

THE total length of this railway, which extended from the Eiskeller in the Schwimmschul-Allee to the northern entrance of the Rotunda, was 1528·3 meters; the gauge was 1 meter, and 60 per cent. of the length consisted of tangents, the remaining 40 per cent. being mostly curves of 250 meters radius. The gradients, three in number, were very small, averaging about 1 : 750.

Two generating dynamos were used, which were coupled in parallel circuit, but in such a manner that the difference of potential in both machines remained the same at all times. This was accomplished by the well known method of coupling introduced by Siemens and Halske, in which the current of one machine excites the field of the other.

Although the railroad was not built with a view of obtaining a high efficiency, an electro-motive force of only 150 volts being used, a mechanical efficiency of 50 per cent. was nevertheless obtained, both with one generator and one car with thirty passengers, as well as with two generators and two cars with sixty passengers; while with two generators and three cars (two of them having motors) the same result was shown.

The curves obtained by the apparatus that recorded the current showed very plainly the action within the machines when the cars were started or set in motion; at first the current rose rapidly to a very high figure, and then declined gradually to a fixed point, which corresponded to the regular rate of speed. The tractive power, therefore, increases rapidly to a value far exceeding the frictional resistances, but this surplus energy serves to increase the velocity, and disappears as soon as a uniform velocity is reached.

The average speed, both with one and three cars, was 30 kilometers per hour.—*Zeitsch. f. Elektrotechnik.*

INSTRUCTION IN MECHANICAL ENGINEERING.

By Professor R. H. Thurston.

The writer has often been asked by correspondents interested in the matter of technical and trade education to outline a course of instruction in mechanical engineering, such as would represent his idea of a tolerably complete system of preparation for entrance into practice. The synopsis given at the end of this article was prepared in the spring of 1871, when the writer was on duty at the U. S. Naval Academy, as Assistant Professor of Natural and Experimental Philosophy, and, being printed, was submitted to nearly all of the then leading mechanical engineers of the United States, for criticism, and with a request that they would suggest such alterations and improvements as might seem to them best. The result was general approval of the course, substantially as here written. This outline was soon after proposed as a basis for the course of instruction adopted at the Stevens Institute of Technology, at Hoboken, to which institution the writer was at about that time called. He takes pleasure in accepting a suggestion that its publication in the Scientific American would be of some advantage to many who are interested in the subject.

The course here sketched, as will be evident on examination, includes not only the usual preparatory studies pursued in schools of mechanical engineering, but also advanced courses, such as can only be taught in special schools, and only there when an unusual amount of time can be given to the professional branches, or when post graduate courses can be given supplementary to the general course. The complete course, as here planned, is not taught in any existing school, so far as the writer is aware. In his own lecture room the principal subjects, and especially those of the first part of the work, are presented with tolerable thoroughness; but many of the less essential portions are necessarily greatly abridged. As time can be found for the extension of the course, and as students come forward better prepared for their work, the earlier part of the subject is more and more completely developed, and the advanced portions are taken up in greater and greater detail, each year giving opportunity to advance beyond the limits set during the preceding year.

Some parts of this scheme are evidently introductory to advanced courses of study which are to be taken up by specialists, each one being adapted to the special instruction of a class of students who, while pursuing it, do not usually take up the other and parallel courses. Thus, a course of instruction in Railroad Engineering, a course in Marine Engineering, or a course of study in the engineering of textile manufactures, may be arranged to follow the general course, and the student will enter upon one or another of these advanced courses as his talents, interests, or personal inclinations may dictate. At the Stevens Institute of Technology, two such courses—Electrical and Marine Engineering—are now organized as supplementary of the general course, and are pursued by all students taking the degree of Mechanical Engineer. These courses, as there given, however, are not fairly representative of the idea of the writer, as above expressed, since the time available in general course is far too limited to permit them to be developed beyond the elements, or to be made, in the true sense of the term, advanced professional courses. Such advanced courses as the writer has proposed must be far more extended, and should occupy the whole attention of the student for the time. Such courses should be given in separate departments under the direction of a General Director of the professional courses, who should be competent to determine the extent of each, and to prevent the encroachment of the one upon another; but they should each be under the immediate charge of a specialist capable of giving instruction in the branch assigned to him, in both the theoretical and purely scientific, and the practical and constructive sides of the work. Every such school should be organized in such a manner that one mind, familiar with the theory and the practice of the professional branches taught, should be charged with the duty of giving general direction to the policy of the institution and of directing the several lines of work confided to specialists in the different departments. It is only by careful and complete organization in this, as in every business, that the best work can be done at least expense in time and capital.

In this course of instruction in Mechanical Engineering it will be observed that the writer has incorporated the scheme of a workshop course. This is done, not at all with the idea that a school of mechanical engineering is to be regarded as a "trade school," but that every engineer should have some acquaintance with the tools and the methods of work upon which the success of his own work is so largely dependent. If the mechanical engineer can acquire such knowledge in the more complete course of instruction of the trade school, either before or after his attendance at the technical school, it will be greatly to his advantage. The technical school has, however, a distinct field; and its province is not to be confounded with that of the trade school. The former is devoted to instruction in the theory and practice of a profession which calls for service upon the men from the latter—which makes demand upon a hundred trades—in the prosecution of its designs. The latter teaches, simply, the practical methods of either of the trades subsidiary to the several branches of engineering, with only so much of science as is essential to the intelligent use of the tools and the successful application of the methods of work of the trade taught. The distinction between the two departments of education, both of which are of comparatively modern date, is not always appreciated in the United States, although always observed in those countries of Europe in which technical and trade education have been longest pursued as essential branches of popular instruction. Throughout France and Germany, every large town has its trade schools, in which the trades most generally pursued in the place are systematically taught; and every large city has its technical school, in which the several professions allied to engineering are studied with special development of those to which the conditions prevailing at the place give most prominence and local importance.

A course of trade instruction, as the writer would organize it, would consist, first, in the teaching of the apprentice the use of the tools of his trade, the nature of its materials, and the construction and operation of the machinery employed in its prosecution. He would next be taught how to shape the simpler geometrical forms in the materials of his trade, getting out a straight prism, a cylinder, a pyramid, or a sphere, of such size and form as may be convenient; getting lines and planes at right angles, or working to miter; practicing the working of his "job" to definite size, and to the forms given by drawings, which drawings should be made by the apprentice himself. When he is able to do good work of this kind, he should attempt larger work, and the construction of parts of structures involving exact fitting and special manipulations. The course, finally, should conclude with exercises in the construction and erection of complete structures and in the making of peculiar details, such as are regarded by the average workman as remarkable "*tours de force*." The trade school usually gives instruction in the common school branches of education, and especially in drawing, free hand and mechanical, carrying them as far as the successful prosecution of the trade requires. The higher mathematics, and advanced courses in physics and chemistry, always taught in schools of engineering, are not taught in the trade school, as a rule; although introduced into those larger schools of this class in which the aim is to train managers and proprietors, as well as workmen. This is done in many European schools.

As is seen above, the course of instruction in mechanical engineering includes some trade education. The engineer is dependent upon the machinist, the founder, the patternmaker, and other workers at the trades, for the proper construction of the machinery and structures designed by him. He is himself, in so far as he is an engineer, a designer of constructions, not a constructor. He often combines, however, the functions of the engineer, the builder, the manufacturer, and the dealer, in his own person. No man can carry on, successfully, any business in which he is not at home in every detail, and in which he cannot instruct every subordinate, and cannot show every person employed by him precisely what is wanted, and how the desired result can be best attained. The engineer must, therefore, learn, as soon and as thoroughly as possible, enough of the details of every art and trade, subsidiary to his own department of engineering, to enable him to direct, with intelligence and confidence, every operation that contributes to the success of his work. The school of engineering should therefore be so organized that the young engineer may be taught the elements of every trade which is likely to find important application in his professional work. It cannot be expected that time can be given him to make himself an expert workman, or to acquire the special knowledge of details and the thousand and one useful devices which are an important part of the stock in trade of the skilled workman; but he may very quickly learn enough to facilitate his own work greatly, and to enable him to learn still more, with rapidity and ease, during his later professional life. He must also, usually, learn the essential elements and principles of each of several trades, and must study their relations to his work, and the limitations of his methods of design and construction which they always, to a greater or less extent, cause by their own practical or economical limitations. He will find that his designs, his methods of construction, and of fitting up and erecting, must always be planned with an intelligent regard to the exigencies of the shop, as well as to the aspect of the commercial side of every operation. This extension of trade education for the engineer into several trades, instead of its restriction to a single trade, as is the case in the regular trade school, still further limits the range of his instruction in each. With unusual talent for manipulation, he may acquire considerable knowledge of all the subsidiary trades in a wonderfully short space of time, if he is carefully handled by his instructors, who must evidently be experts, each in his own trade. Even the average man who goes into such schools, following his natural bent, may do well in the shop course, under good arrangements as to time and character of instruction. If a man has not a natural inclination for the business, and a natural aptitude for it, he will make a great mistake if he goes into such a school with the hope of doing creditable work, or of later attaining any desirable position in the profession.

The course of instruction, at the Stevens Institute of Technology, includes instruction in the trades to the extent above indicated. The original plan, as given below, included such a course of trade education for the engineer; but it was not at once introduced. The funds available from an endowment fund crippled by the levying of an enormous "succession tax" by the United States government and by the cost of needed apparatus and of unanticipated expenses, in buildings and in organization, were insufficient to permit the complete organization of this department. A few tools were gathered together; but skilled mechanics could not be employed to take up the work of instruction in the several courses. Little could therefore be done for several years in this direction. In 1875 the writer organized a "mechanical laboratory," with the purpose of attaining several very important objects: the prosecution of scientific research in the various departments of engineering work; the creation of an organization that should give students an opportunity to learn the methods of research most usefully employed in such investigations; the assistance of members of the profession and business organizations in the attempt to solve such questions, involving scientific research, as are continually arising in the course of business; the employment of students who had done good work in their college course, when they so desire, in work of investigation with a view to giving them such knowledge of this peculiar line of work as should make them capable of directing such operations elsewhere; and finally, but not least important of all, to secure, by earning money in commercial work of this kind, the funds needed to carry on those departments of the course in engineering that had been, up to that time, less thoroughly organized than seemed desirable. This "laboratory" was organized in 1875, the funds needed being obtained by drawing upon loans offered by friends of the movement and by the "Director."

It was not until the year 1878, therefore, that it became possible to attempt the organization of the shop course; and it was then only by the writer assuming personal responsibility for its expenses that the plan could be entered upon. As then organized—in the autumn of 1878—a superintendent of the workshop had general direction of the trade department of the school. He was instructed to submit to the writer plans, in detail, for a regular course of shop instruction, and was given as assistants a skilled mechanic of unusual experience and ability, whose compensation was paid from the mechanical laboratory funds, and guaranteed by the writer personally, and another aid whose services were paid for partly by the Institute and partly as above. The pay of the superintendent was similarly assured. This scheme had been barely entered upon when the illness of the writer compelled him to temporarily give up his work, and the direction of the new organization fell into other hands, although the department was carried on, as above, for a year or more after this event occurred.

The plan did not fall through; the course of instruction was incorporated into the college course, and its success was finally assured by the growth of the school and a corresponding growth of its income, and, especially, by the liberality of President Morton, who met expenses to the amount of many thousands of dollars by drawing upon his own bank account. The department was by him completely organized, with an energetic head, and needed support was given in funds and by a force of skilled instructors. This school is now in successful operation. This course now also includes the systematic instruction of students in experimental work, and the objects sought by the writer in the creation of a "mechanical laboratory" are thus more fully attained than they could have possibly been otherwise. It is to be hoped that, at some future time, when the splendid bequest of Mr. Stevens may be supplemented by gifts from other equally philanthropic and intelligent friends of technical education, among the alumni of the school and others, this germ of a trade school may be developed into a complete institution for instruction in the arts and trades of engineering, and may thus be rendered vastly more useful by meeting the great want, in this locality, of a real trade school, as well as fill the requirements of the establishment of which it forms a part, by giving such trade education as the engineer needs and can get time to acquire.

The establishment of advanced courses of special instruction in the principal branches of mechanical engineering may, if properly "dovetailed" into the organization, be made a means of somewhat relieving the pressure that must be expected to be felt in the attempt to carry out such a course as is outlined below. The post-graduate or other special departments of instruction, in which, for example, railroad engineering, marine engineering, and the engineering of cotton, woolen, or silk manufactures, are to be taught, may be so organized that some of the lectures of the general course may be transferred to them, and the instructors in the latter course thus relieved, while the subjects so taught, being treated by specialists, may be developed more efficiently and more economically.

Outlines of these advanced courses, as well as of the courses in trade instruction comprehended in the full scheme of mechanical engineering courses laid out by the writer a dozen years ago, and as since recast, might be here given, but their presentation would occupy too much space, and they are for the present omitted.

The course of instruction in this branch of engineering, at the Stevens Institute of Technology, is supplemented by "Inspection Tours," which are undertaken by the graduating class toward the close of the last year, under the guidance of their instructors, in which expeditions they make the round of the leading shops in the country, within a radius of several hundred miles, often, and thus get an idea of what is meant by real business, and obtain some notion of the extent of the field of work into which they are about to enter, as well as of the importance of that work and the standing of their profession among the others of the learned professions with which that of engineering has now come to be classed.

At the close of the course of instruction, as originally proposed, and as now carried out, the student prepares a "graduating thesis," in which he is expected to show good evidence that he has profited well by the opportunities which have been given him to secure a good professional education. These theses are papers of, usually, considerable extent, and are written upon subjects chosen by the student himself, either with or without consultation with the instructor. The most valuable of these productions are those which present the results of original investigations of problems arising in practice or scientific research in lines bearing upon the work of the engineer. In many cases, the work thus done has been found to be of very great value, supplying information greatly needed in certain departments, and which had previously been entirely wanting, or only partially and unsatisfactorily given by authorities. Other theses of great value present a systematic outline of existing knowledge of some subject which had never before been brought into useful form, or made in any way accessible to the practitioner. In nearly all cases, the student is led to make the investigation by the bent of his own mind, or by the desire to do work that may be of service to him in the practice of his profession. All theses are expected to be made complete and satisfactory to the head of department of Engineering before his signature is appended to the diploma which is finally issued to the graduating student. These preliminaries being completed, and the examinations having been reported as in all respects satisfactory, the degree of Mechanical Engineer is conferred upon the aspirant, and he is thus formally inducted into the ranks of the profession.

Course of Instruction in Mechanical Engineering.

Robert H. Thurston—July, 1871.

I.

Materials used in Engineering.—Classification, Origin, and Preparation (where not given in course of Technical Chemistry), Uses, Cost.

Strength and Elasticity.—Theory (with experimental illustrations), reviewed, and tensile, transverse and torsional resistance determined.

Forms of greatest strength determined. *Testing* materials.

Applications.—Foundations, Framing in wood and metal.

Friction.—Discussion from Rational Mechanics, reviewed and extended.

Lubricants treated with materials above.

Experimental determination of "coefficients of friction."

II.

Tools.—Forms for working wood and metals. Principles involved in their use.

Principles of pattern making, moulding, smith and machinists' work so far as they modify design.

Exercises in Workshops in mechanical manipulation.

Estimates of *cost* (stock and labor).

Machinery and Mill Work.—Theory of machines. Construction. Kinematics applied. Stresses, calculated and traced. Work of machines. Selection of materials for the several parts. Determination of *proportions* of details, and of *forms* as modified by difficulties of construction.

Regulators, Dynamometers, Pneumatic and Hydraulic machinery. Determining *moduli* of machines.

Power, transmission by gearing, belting, water, compressed air, etc.

Loads, transportation.

III.

History and Present Forms of the Prime Movers.

Windmills, their theory, construction, and application.

Water Wheels. Theory, construction, application, testing, and comparison of principal types.

Air, Gas, and Electric Engines, similarly treated.

Steam Engines.—Classification. [Marine (merchant) Engine assumed as representative type.] Theory. Construction, including general design, form and proportion of details.

Boilers similarly considered. Estimates of *cost*.

Comparison of principal types of Engines and Boilers.

Management and repairing. Testing and recording performance.

IV.

MOTORS APPLIED to Mills. Estimation of required power and of *cost*.
Railroads. Study of Railroad machinery.
Ships. Structure of Iron Ships and rudiments of Naval architecture and Ship propulsion.

PLANNING Machine shops, Boiler shops, Foundries, and manufactories of textile fabrics. Estimating *cost*.

LECTURES BY EXPERTS.

GENERAL SUMMARY of principal facts, and natural laws, upon the thorough knowledge of which successful practice is based; and general *resume* of principles of business which must be familiar to the practicing engineer.

V.

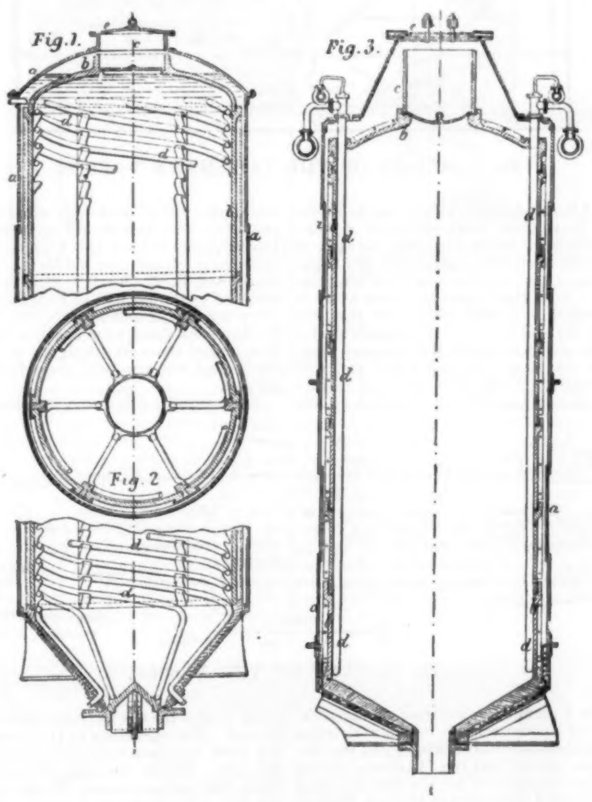
GRADUATING THESES.

GRADUATION.

Accompanying the above are courses of instruction in higher mathematics, graphics, physics, chemistry, and the modern languages and literatures.

IMPROVED DOUBLE BOILER.

THE operation of boiling substances under pressure with more or less dilute sulphuric or sulphurous acid forms a necessary stage of several important manufactures, such as the production of paper from wood, the extraction of sugar, etc. A serious difficulty attending this process arises from the destructive action of the acid upon the boiler or chamber in which the operation is carried on, and as this vessel, which is generally of large dimensions, is exposed to considerable pressures, it is necessarily constructed of iron or some other sufficiently resisting metal. An ingenious method of avoiding this difficulty has been devised, we believe in Germany, and has been put into practice with a certain amount of success. It consists in lining the iron boiler with a covering of lead, caused by fusion to unite firmly to the walls of the boiler, and thus to protect it from the action of the acid. No trouble, it is stated, is found to arise from the difference in expansion of the two metals, which, moreover, adhere fairly well; but, on the other hand, we believe it does actually occur that the repairs to this lead lining are numerous, tedious, and costly of execution, so that the system can scarcely be regarded as meeting the requirements of the manufacturer. It is to secure all the advantages possessed by a lead-lined vessel, without the drawback of frequent and expensive repairs, that the digester, of which we annex illustrations, has been devised by Mr. George Knowles, of Billiter House, Billiter Street. It consists of a closed iron cylindrical vessel suitable for boiling under pressure, and containing a second vessel open at the top, and of such a diameter as to leave an annular space between it and the walls of the outer shell. This inner receiver, which may be made of lead, glass, pottery, or any other suitable material, contains the substance to be treated and the sulphurous acid or other solution in which it is to be boiled. The annular space between the two vessels is filled with water to the same level as the solution in the receiver, and the latter is provided with suitable pipes or coils, in which steam is caused to circulate for the purpose of raising the solution of the desired temperature, and effecting the digesting process. At the same time any steam generated collects in the upper part of the boiler, and maintains an equal pressure within the whole apparatus. Figs. 1 to 3 show the arrangement clearly. Within the boiler, *a*, is placed the receiver, *b*, of pottery, lead, or other material, leaving an annular space between it and the boiler; this space is filled with water. The receiver, *b*, is furnished with a series of pipes, in which steam or hot water circulates, to heat the charge to the desired temperature. These pipes may be arranged either in coils, as shown at *d*, Fig. 1, or vertically at *d*, Fig. 3. The latter are provided with inner return pipes, so that any condensed water accumulating at the bottom may be forced up the inner pipes by the steam pressure and escape at the top. The vessel is charged through the manhole, *e*, and the hopper, *c*, provided with a perforated cover, and is discharged at the bottom by the valve, *f*, shown in Figs. 2 and 3. The upper part of the boiler serves as a steam dome, and the pressure on the liquid in the receiver and on the water in the annular space is thereby maintained uniform. The necessary fittings for showing the pressure in the vessel, water level indicator, safety valve, cocks for testing solutions, etc., are of course added to the apparatus, but are not indicated in the drawing. The arrangement appears to us to possess considerable merit, and we shall refer to it again on another occasion, after experiments have been made to test its efficiency.—*Engineering.*



IMPROVED DOUBLE BOILER.

THE GARDNER MACHINE GUN.

THE mechanism by which the various functions of loading, firing, and extracting are performed is contained in a rectangular gun metal case, varying in dimensions with the number of barrels in the arm. In the single barrel gun the size of this case is 14 inches in length, 5½ inches in depth, and 2½ inches in width. The top of the box is hinged, so that easy access can be had to the mechanism, which consists of a lock, the cartridge carrier, and the devices for actuating them. In the multiple barrel guns, the frames which, with the transverse bar at the end, hold the barrels in place, form the sides of the mechanism chamber, in the front end of which the barrels are screwed. The mechanism is actuated by a cam shaft worked by a hand crank on one side of the chamber. By this means the locks are driven backward and forward, the latter motion forcing the cartridges into place, and the former withdrawing the empty cartridge case after firing. The extractor hook pivoted to the lock plunger rises, as the lock advances, over the rim of the case, but is rigid as the lock is withdrawn, so that the action is a positive one. The cartridges, which are contained in a suitable frame attached to the forward part of the breech chamber, pass through openings in the top plate of the latter, an efficient distribution being secured by means of a valve having a transverse motion. Each cartridge as it falls is brought into the axis of the barrel and the plunger, while the advance motion of the lock forces them into position. In the five-barrel gun illustrated by Fig. 3 the cartridge feeder contains 100 cartridges, in five vertical rows of 20 cartridges each, and these are kept supplied, when firing, from supplementary holders. Fig. 1 shows the portable rest manufactured by the Gardner Gun Company. It consists of two wrought iron tubes, placed at right angles to each other; the front bar can be easily unlocked, and placed in line with the trail bar, from which project two arms, each provided with a screw that serves for the lateral adjustment of the gun.

FIG. 2.—TWO BARREL GARDNER GUN.

FIG. 3.—FIVE BARREL GARDNER GUN.

FIG. 1.—SINGLE BARREL GARDNER MACHINE GUN.

These screws are so arranged as to allow for an oscillating motion of the gun through any distance up to 15 deg. The tripod mounting, used for naval as well as land purposes, is shown in Fig. 2, which illustrates the two barrel gun complete. The five barrel gun, Fig. 3, is shown mounted on a similar tripod. The length of this weapon over all is 53·5 inches, the barrels (Henry system) are 33 inches long, with seven grooves of a uniform twist of one turn in 22 inches.

Gardener's five barrel gun in the course of one of the trials fired 16,754 rounds with only 2·4 jams, and in rapid firing reached a maximum of 330 shots in 30 seconds. The two barrel gun fired 6,929 rounds without any jam; the last 3,000 being in 11 minutes 39 seconds, without any cleaning or oiling.—*Engineering.*

CLIMBING TRICYCLES.

THE cycle trade is one which has been developed with great rapidity within the last ten years, and, like all new industries, has called forth a considerable amount of ingenuity and skill on the part of those engaged in it. We cannot help thinking, however, that much of this ingenuity has been misplaced, and that instead of striving after new forms involving considerable complication and weight, it would have been better and more profitable if manufacturers had moderated their aspirations, and aimed at greater simplicity of design; for it must be remembered that cyclists are, as a rule, without the slightest mechanical knowledge, while the machines themselves are subject to very hard usage and considerable wear and tear in traveling over the ordinary roads in this country. We refer, of course, more especially to tricycles, which in one form or another are fast taking the place of bicycles, and which promise to assume an important position in every day locomotion. Hitherto one of the chief objections to the use of the tricycle has been the great difficulty experienced in climbing hills, a very slight ascent being sufficient to tax the powers of the rider to such an extent as to induce if not compel him in most instances to dismount and wheel his machine along by hand until more favorable ground is reached. To obviate this inconvenience many makers have introduced some arrangement of gearing speeds of two powers giving the necessary variation for traveling up hill and on the level. We noticed, however, one machine at the exhibition which seemed to give all that could be desired without any gearing or chains at all. This was a direct action tricycle shown by the National Cycle Company, of Coventry, in which the pressure from the foot is made to bear directly upon the main axle, and so transmitted without loss to the driving wheels on each side, the position of the rider being arranged so that just sufficient load is allowed to fall on the back wheel as to obtain certainty in steerage. The weight of this machine is much less than when gearing is used, and the friction is also considerably reduced, trials with the dynamometer having shown that on a level, smooth road, a pull of 1 lb. readily moved it, while with a rider in the seat 4 lb. was sufficient. On this tricycle any ordinary hill can, it is stated, be ascended with great ease, and as a proof of its power it was exhibited at the Stanley show climbing over a piece of wood 8 in. high, without any momentum whatever. We understand that at the works at Coventry a flight of stairs has been erected, and that no difficulty is experienced in ascending them on one of these machines.—*The Engineer.*

SUBMARINE EXPLORATIONS.

VOYAGE OF THE TALISMAN.

IT was but a few years ago that the idea was prevalent that the seas at great depths were immense solitudes where life exhibited itself under no form, and where an eternal night reigned. To-day, thanks to expeditions undertaken for the purpose of exploring the abysses of the ocean, we know that life manifests itself abundantly over the bottom, and that at a depth of five and six thousand meters light is distributed by innumerable phosphorescent animals. Different nations have endeavored to rival each other in the effort to effect these important discoveries, and several scientific missions have been sent to different points of the globe by the English and American governments. The French likewise have entered with enthusiasm upon this new line of research, and for four consecutive years, thanks to the devoted aid of the ministry of the marine, savants have been enabled to take passage in government vessels that were especially arranged for making submarine explorations.

The first French exploration, which was an experimental trip, was made in 1880 by the Travailleur in the Gulf of Gascogne. Its unhoped for results had so great an importance that the following year the government decided to continue its researches, and the Travailleur was again put at the disposal of Mr. Alph. Milne Edwards and the commission over which he presided. Mr. Edwards traversed the Gulf of Gascogne, visited the coast of Portugal, crossed the Strait of Gibraltar, and explored a great portion of the Mediterranean. In 1882 the same vessel undertook a third mission to the Atlantic Ocean, and as far as to the Canary Islands. The Travailleur, however, being a side-wheel advice-boat designed for doing service at the port of Rochefort, presented none of those qualities that are requisite for performing voyages that are necessarily of long duration. The quantity of coal that could be stored away in her bunkers was consumed in a week, and, after that, she could not sail far from the points where it was possible for her to coal up again. So after her return Mr. Edwards made a request for a ship that was larger, a good sailer, and that was capable of carrying with it a sufficient supply of fuel for remaining a long time at sea, and that was adapted to submarine researches. The Commission indorsed this application, and the Minister of Instruction received it and transmitted it to Admiral Jauréguiberry—the Minister of the Marine—who at once gave orders that the Talisman should be fitted up and put in commission for the new dredging expedition. This vessel, under command of Captain Parfait, who the preceding year had occupied the same position on the Travailleur, left the port of Rochefort on the 1st of June, 1883, having on board Mr. Milne Edwards and the scientific commission that had been appointed by the Minister of Public Instruction. The Talisman explored the coasts of Portugal and Morocco, visited the Canary and Cape Verd Islands, traversed the Sea of Sargasso, and, after a stay of some time at the Azores, returned to France, after exploring on its way the Gulf of Gascogne (Fig.).

The magnificent collections in natural history that were collected on this cruise, and during those of preceding years made by the Travailleur, are, in a few days, to be exhibited at the Museum of Natural History. We think we shall be doing a service to the readers of this journal, in giving them some details as to the organization of the Talisman expedition as well as to the manner in which the dredgings were performed.

The vessel, as shown by her plan in Fig. 2, had to undergo important alterations for the cruise that she was to undertake. Her deck was almost completely freed from artillery, since this would have encumbered her too much. Immediately behind the bridge, in the center of the vessel, there were placed two windlasses, one, A, to the right, and the other, B, to the left (Fig. 2). These machines, whose mode of operation will be explained further along, were to serve for raising and lowering the fishing apparatus. A little further back there were constructed two cabins, G and HH. The first of these was designed to serve as a laboratory, and the second was arranged as quarters for the members of the mission.

The sounding apparatus, the Brothergood engine for actuating it, and the electric light apparatus were placed upon the bridge. The operating of the sounding line and of the electric light was therefore entirely independent of that of the dredges. On the foremast, at a height of about two meters, there was placed a crane, F, which was capable of moving according to a horizontal plane. Its apex, as may be seen from the plan of the boat, was capable of projecting beyond the sides of the ship, to the left and right. To this apex was fixed a pulley over which ran the cable that supported the dredges or bag-nets, which latter were thus carried over the boat's sides.

The preliminary operation in every submarine exploration consists in exactly determining the depth of the sea immediately beneath the vessel. To effect this object different sounding apparatus have been proposed. As the trials that were made of these had shown that each of them possessed quite grave defects, Mr. Thibaudier, an engineer of the navy, installed on board the Talisman last year a new sounding apparatus which had been constructed according to directions of his and which have given results that are marvelous. The apparatus automatically registers the number of meters of wire that is paid out, and as soon as the sounding lead touches bottom, it at once stops of itself. This

FIG. 1.—CHART OF THE TALISMAN'S VOYAGE

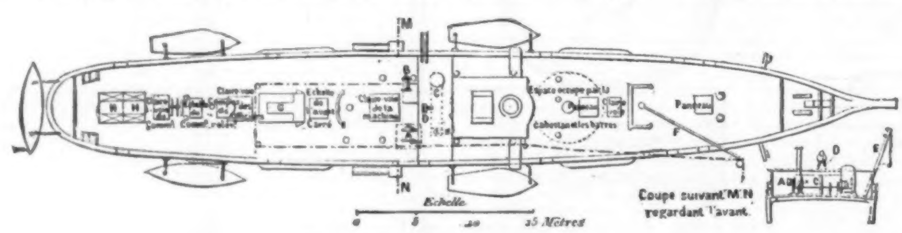
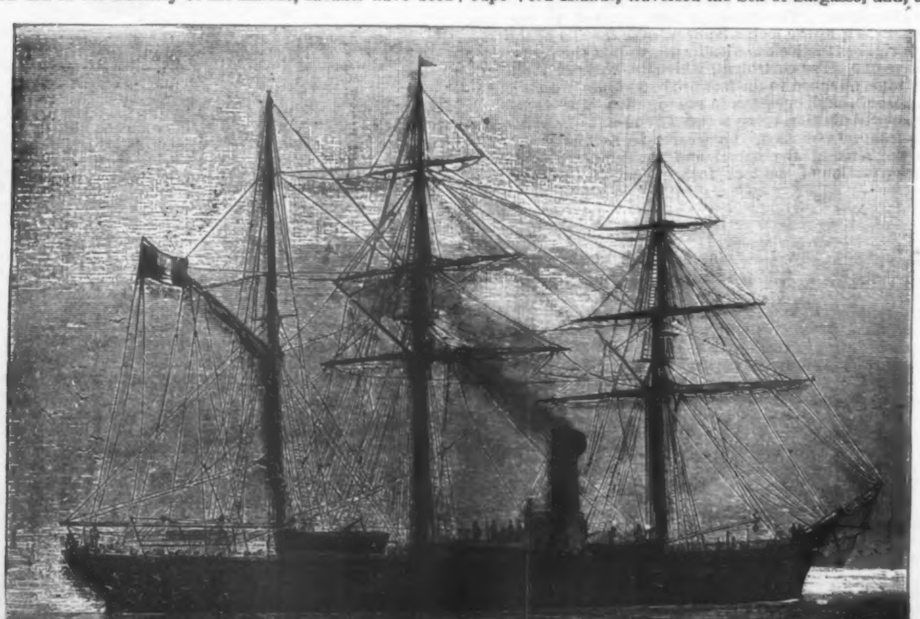


FIG. 2.—PLAN OF THE VESSEL.



THE FRENCH SCIENTIFIC STEAMER TALISMAN.

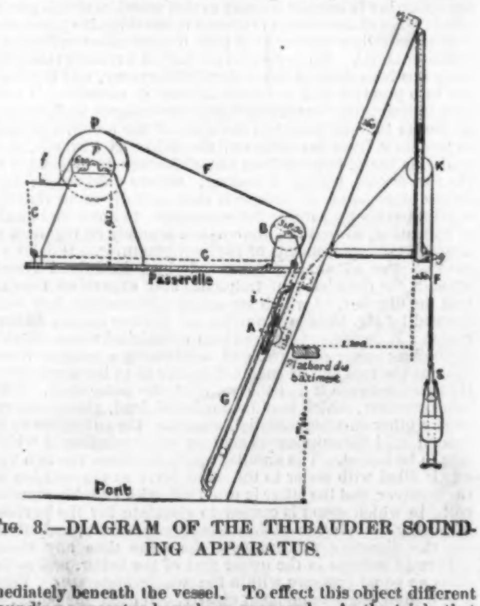


FIG. 3.—DIAGRAM OF THE THIBAUDIER SOUNDING APPARATUS.

apparatus is shown in Fig. 4, and a diagram of it is given in Fig. 3, so that its operation may be better understood. The Thibaudier sounding apparatus consists of a pulley, P (Fig. 3), over which is wound 10,000 meters of steel wire one millimeter in diameter. From this pulley, the wire runs over a pulley, B, exactly one meter in circumference; from thence it runs to a carriage, A, which is movable along wooden shears, runs up over a fixed pulley, K, and reaches the sounding lead, S, after traversing a guide, g, where there is a small sheave upon which it can bear, whatever be the inclination of the boat. The wheel, B, carries upon its axle an endless screw that sets in motion two toothed wheels that indicate the number of revolutions that it is making. One of these marks the units and the other the hundredths (Fig. 5). This last is graduated up to 10,000 meters. As every revolution of the wheel, B, corresponds to one meter, the number indicated by the counter represents the depth. Upon the axle of the winding pulley there is a break pulley, p. The brake, f, is maneuvered by a lever, L, at whose extremity there is a cord, C, which is made fast to the carriage, A. When, during the motions due to rolling, the tension of the steel wire that supports the lead diminishes or increases, the carriage slightly rises or falls, and, during these motions, acts more or less upon the brake and consequently regulates the velocity with which the wire unwinds. When the lead touches bottom, the wire, being suddenly relieved from all weight (which is sometimes as much as 70 kilos), instantly stops.

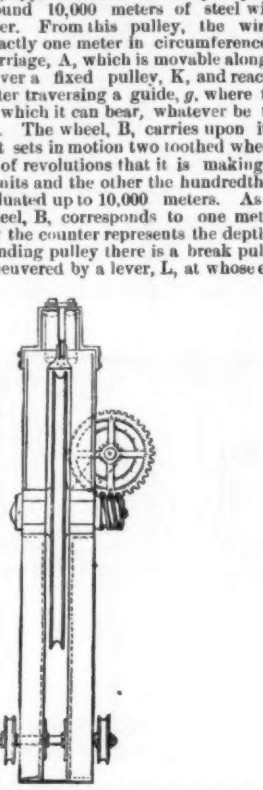


FIG. 5.—APPARATUS FOR MEASURING THE LENGTH OF THE WIRE PAID OUT.

The maneuver of this apparatus may be readily understood. The apparatus and its weights are arranged in the interior of the vessel. A man bears upon the lever, L (Fig. 3), and the counter is set at zero. All being thus arranged, the man lets go of the break, and the unwinding then proceeds until the lead has touched bottom. During the operation of sounding, the boat is kept immovable by means of its engine, so that the wire shall remain as vertical as possible. The bottom being reached, the unwinding suddenly ceases, and there is nothing further to do but read the indication given by the differential counter, this giving the depth.

Near the winding pulley, there is a small auxiliary engine, M, which is then geared with the axle of the said pulley, and which raises the sounding apparatus that has been freed from its weight by a method that will be described further along.

We have endeavored in Fig. 4 to show the aspect of the bridge at the moment when a sounding was about being made. From this engraving (made from a photograph) our readers may obtain a clear idea of the Thibaudier sounding apparatus, and understand how the wheel over which the wire runs is set in motion by the Brothergood engine.—*La Nature.*

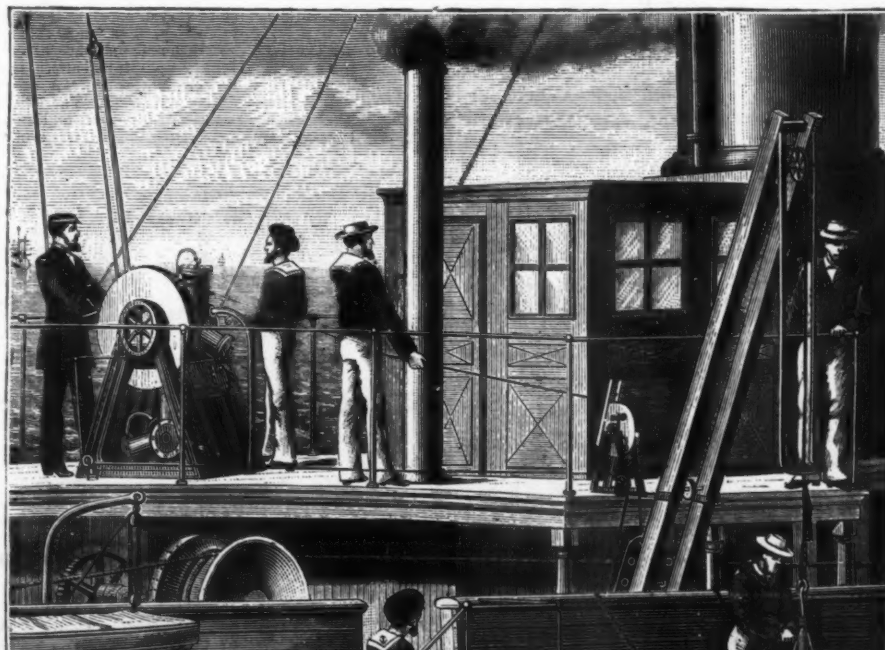
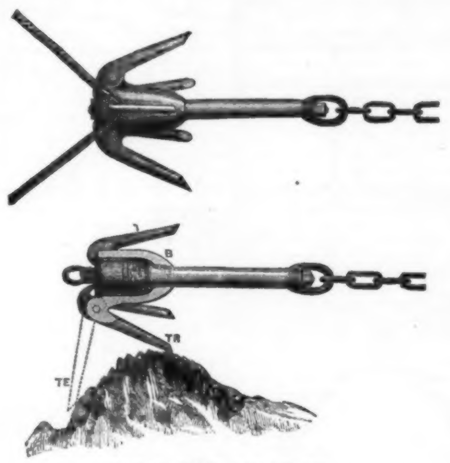


FIG. 4.—GENERAL VIEW OF THE SOUNDING APPARATUS IN THE "TALISMAN."

CABLE GRAPNEL.

SOME improvements have recently been made by Mr. Alexander Glegg and the inventor in the well-known Jamieson grapnel used for raising submerged submarine cables. The



JAMIESON'S GRAPNEL.

chief feature of the grapnel is that the flukes, being jointed at the socket, bend back against a spring when they catch a rock, until the grapnel clears the obstruction, but allow the cable to run home to the crutch between the fluke and base, as shown in the figures. In the older form the cable was liable to get jammed, and cut between the fixed toe or fluke and the longer fluke jointed into it. This is now avoided by embracing the short fluke within the longer one. The shank, formerly screwed into the boss, is now pushed through and kept up against the collar of the boss, by the volute spring, which at the same time presses back the hinged flukes after being displaced by a rock. The shank can now freely swivel round, whereas before it was rigidly fixed. The toes or flukes are now made of soft cast steel, which can be straightened if bent, and the boss is made of cast steel or gun-metal.

WRETCHED BOILERMAKING.

To the Editor of the Scientific American:

As long as I have been a reader of the SCIENTIFIC AMERICAN I have been pleased with the manner in which you investigate and explain the cause of any boiler explosion which comes to your knowledge; and I have rejoiced when you heaped merited censure upon the fraudulent boilermaker. In your paper in December last you copied a short article on "Conscience in Boilermaking," in which the writer, after speaking of the tricks of the boilermaker in using thinner iron for the center sheets than for the others, and in "upsetting" the edges of the plates to make them appear thicker, goes on to say: "We call attention to this, because the discovery of such practice has made serious trouble between the boilermaker and the steam user. We would not believe that there were men so blind to the duties and obligations which rest upon them as to resort to such practice, but the careful inspector finds all such defects, and in time we come to know whose work is carefully and honestly done, and whose is open to suspicion. In States and cities where inspection laws are in force that give the methods and rules by which the safe working pressure of a boiler is calculated, there is no alternative except to follow the rules; and if certain requirements regarding construction are a part of the law, there is no authority or right to depart from it, and yet there are boilermakers who try to force their boilers into such localities when their work is not up to the requirements of the law."

Now, if some boilermakers are so dishonest as to try and impose upon the locomotive engineer, who they know will carefully examine every part of his boiler, and who is able to detect any flaw, it is not to be expected that the farmer will escape. Nor does he. The great number of explosions of boilers used in thrashing and in other farm work proves that there are boilermakers who "force their boilers into such localities when their work is not up to the requirements of the law." And the boilermaker, if he be dishonest, is doubly tempted if the broad width of a continent intervenes between him and the farmer for whom his work is intended, and if in the place where the boiler is to be used there are no inspection laws in force. The farmer who lives many miles from a city, and who has no means of testing any boiler he may purchase, is wholly at the mercy of the boilermaker, and must run it until it explodes or time proves it to have been honestly made. Then, again, there are boilermakers who, although making boilers of good iron and of the proper thickness, finish them off so badly that the farmer is put to great inconvenience and expense to put them in working order. Two years ago I purchased a straw-burning engine and boiler made by an Eastern firm. Before it had run ten days the boiler began to leak at the saddle-bolt holes. The engineer tightened the nuts as far as possible, but could not stop the leaks, which at last became so bad that we had to stop work and take the engine to the shop. Upon taking off the saddle and taking out the bolts it was discovered that they were too small for the holes in the boiler, and that they had been wrapped with candle wick and white lead to make them fill the holes, and that a light washer had been put on each bolt between the head and the inside of the boiler. This washer kept the lead in its place, and prevented the boiler from showing a leak when first fired up. The water pipes in the fire-box soon gave out and became utterly useless. Upon inquiring of the patentee of this straw-burning device, who was supposed to have put it in my boiler, he stated that he had had nothing to do with it, but that it was put in by the firm selling these engines, and "as cheaply as possible." Before I got this boiler and engine in fair running order I had spent hundreds of dollars and had to do entirely away with the water grates.

Last summer, needing another tharshing engine, I was induced to buy one of the same make as my old one, but with a different straw-burning device. The firm who sold it to me agreed that it should have none of the faults of the old one. Well, I got it, and, upon hauling it out to my ranch, and getting up steam, I found it to be much worse than the first one I had bought. The boiler leaked at nearly every hole where a tap had been screwed into it. It took an engineer, a boilermaker, a blacksmith, and a fireman several days to get it in shape so that we could use it at all; and after we did start up, the boilermaker had to be sent for several times to stop new leaks that were continually showing themselves.

I send you by this mail for your inspection one of the saddle bolts and one of the bolts taken out of the piston, and also the certificates of the engineer, boilermaker, and machinist who repaired the boiler. In justice to my fellow-farmers I ought to publish these certificates and the names of these boilermakers to the world, but, for the present at least, I refrain from so doing. These boilermakers will see this article and they will know, if the public does not, for whom it is intended. If it has the effect of making them exercise more care in the construction and fitting up of their engines and boilers, I have not written in vain.

D. FREEMAN.

Los Angeles, Cal., March 7, 1884.

[The two bolts and the certificates above referred to accompany the letter of Mr. Freeman. We can only wonder how it was that, after having been treated as he relates in the first instance, he should have had any further business with parties who would send out such boilers, for the testimony of the engineer and workmen make the case even stronger than Mr. Freeman has put it.—ED.]

A THREADED SET COLLAR.

There are cases where a long screw must be rotated with a traversing nut or other threaded piece traveling on its thread a limited and variable distance. At one time the threaded nut or piece may be required to go almost the entire length of the screw, and at another time a much shorter traverse would be required. In many instances the use of side check nuts is inconvenient, and in some it is impossible. One way of utilizing the nut as a set collar is to drill through its side for a set screw, place it on its screw, pour a little melted Babbitt metal, or drop a short, cold plug of it into the hole, tap the hole, and the tap will force the Babbitt into the threads.

Insert the set screw, and when it acts on the Babbitt metal it will force it with great friction on to the thread without injuring the thread; and when the set screw tension is released, the nut turns freely. A similar and perhaps a better result may be obtained by slotting the hole through the nut as though for the reception of a key. Secure a key (preferably of the same material as the nut) by slight upsetting at its ends, and then thread the nut, key, and all. Place a set screw through the nut over the threaded key, and the job is complete.

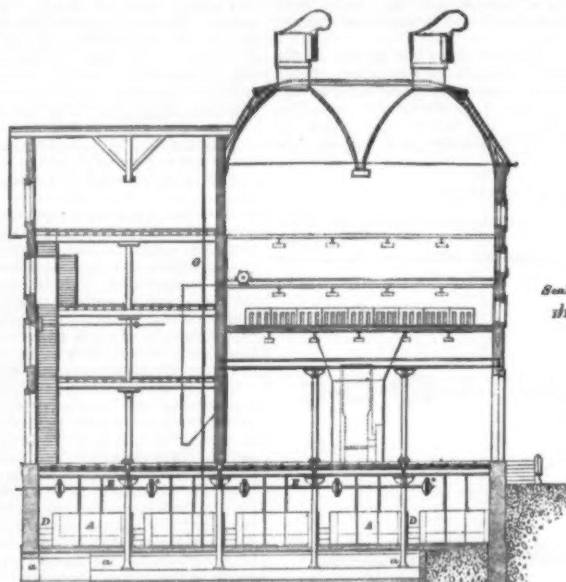
PNEUMATIC MALTING.

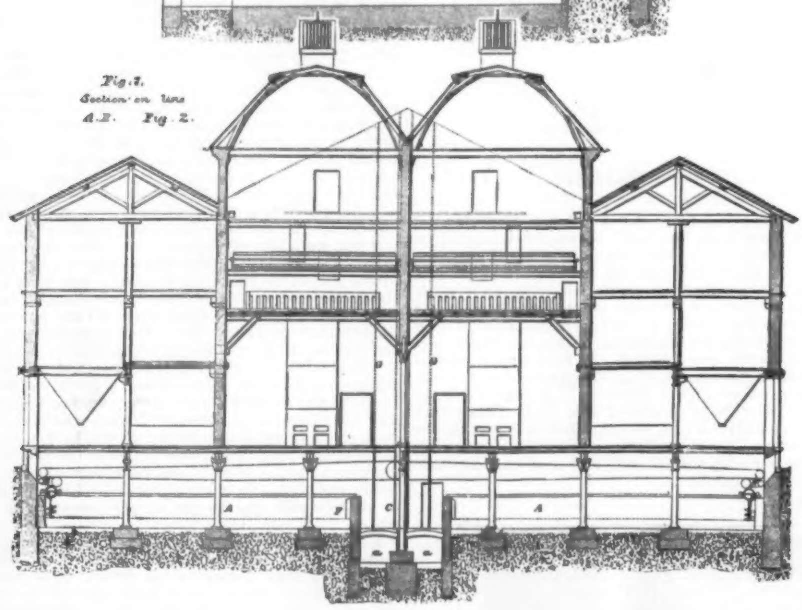
THE lethargy in the malting trade, and in all matters relating to malting processes, induced by two centuries of restrictive legislation, is being gradually shaken off by the malting industry under the new law. For many years nearly all improvements in malting processes originated abroad, as numberless Acts of Parliament fettered every process and the use of every implement requisite in a malt-house in this country. The entire removal of these legislative restrictions gives an opportunity for improved processes, which promises to open up a considerable field for engineering work, and to develop a very backward art by the application of scientific principles. The present time is, therefore, one of more material change than malting has ever experienced.

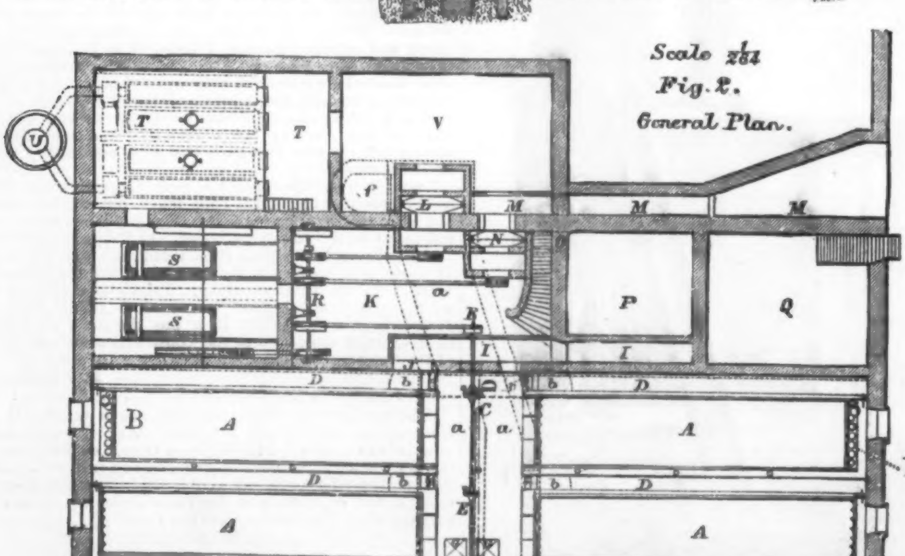
Of the numerous improvements effected in the past few years, those made by M. Galland in France, and more recently by M. Saladin, are by far the most prominent. M. Galland originated what is known as the pneumatic system eight or nine years ago. This system is carried out at the Maxéville brewery, near Nancy.

Since that time further improvements have been made by M. Galland; but more recently great advances have been made in the system by M. Saladin. He has developed the practice of the leading principle, and in conjunction with Mr. H. Stopes, of London, has added improved kilns and various mechanical apparatus for performing the work previously done by hand. He has also devised a very ingenious machine for cooling th moist air by which the process is carried on.

At the recent Brewery Exhibition, some of the machinery







PNEUMATIC MALTING AT TROYES.

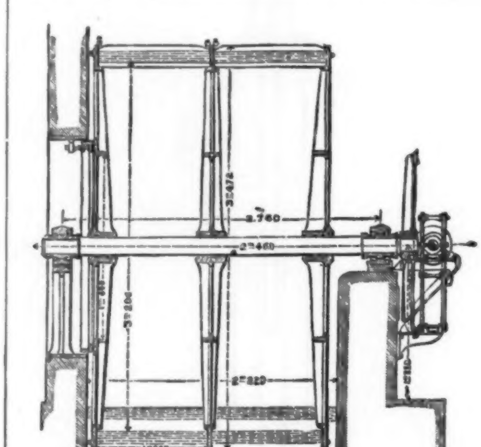


FIG. 5.—ECHANGEUR, AXIAL SECTION.

used in these new maltings was shown in action by Messrs. H. Stopes & Co., together with drawings of a malting constructed at Troyes for M. Bonnette under M. Saladin's instructions. This malting is the third constructed for the same firm, the others being at Nancy. That at Troyes we now illustrate. We will not occupy space by a general description of the pneumatic system, one great feature in which is the continuous manufacture of malt throughout the year instead of only from five to eight months of the year, as it will be gathered from the following description of the Troyes malting:

In our engravings, Figs. 1, 2, and 3, the letter A indicates the germinating cases; B, Saladin's patent turning screws; C A, air channels; D, passages; E R, main driving shafts; *e*, pulleys; F, metal recesses to fit turning screws; G, elevators; H, trap doors; I, air channels; J, openings to growing floor for air; K S, engines and fan room; L N, fans, supply and exhaust; T, boiler; U, chimney; *f*, well. The capacity of the malting is 130 qr. malt every day. This is equivalent to an English house of 520 qr. steep. The whole space occupied is the area necessary for kilns, malt and barley stores, engine and boiler house, and fans. No additional area is required for germinating floors, as ten germinating cases, A, are placed in the basement below the kilns and stores. The building is of brick, with the internal walls below the ground line resting upon cast iron columns and rolled joists. The germinating

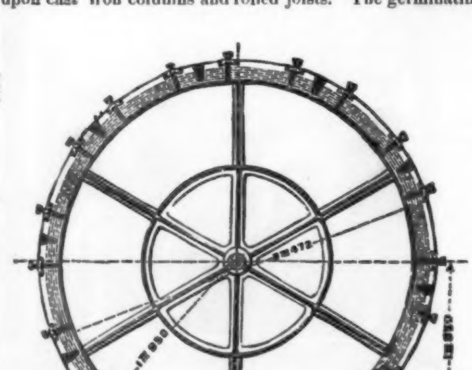


FIG. 6.—ECHANGEUR TRANSVERSE SECTION.

cases, A A, are of iron; the bottoms are double. One of perforated plate is placed 6 inches above the bottom. These plates admit of draining the corn if the germinating case is used as a steeping cistern also. Their chief object is, however to admit of ready circulation of the air by the means presently to be described. Large channels, A *a*, serve as drains for moisture and to convey the air to or from the growing corn. Between each case is a passage, D, enabling the maltster to have free access to the corn at all points.

With the exception of the driving shaft, E, all the machinery is in duplicate, so that the possibility is remote of any breakdown that would seriously affect the working of the house. This is necessary, as should the fans, L N, be stopped for twenty-four hours the corn germinating at a depth exceeding 30 inches would heat and impair its vitality. The boilers, T, and engines, S, are of the common type of 20 horse power nominal. The fans, L N, are the Farcot patent, illustrated a short time since in our pages. The lower floors of the kilns are provided with the Schlemmer

patent mechanical turners. The turners, Fig. 4, in the germinating cases are Saladin's patent.

The germination of the grain is effected by means of cool moist air provided by the fan described and the cooler and moistener—Figs. 5, 6, and 7, herewith—known as an *echangeur*. As the germinating grain has a depth of from 30 inches to 40 inches some pressure is required, and mechanical means are necessary for efficient and economical turning. The *echangeur* is a very ingenious application of the well understood rapidity of evaporation of any liquid when spread out in very thin layers over large surfaces and exposed to a current of air. It consists of a cylinder, or series of cylinders, of increasing diameter, placed one within

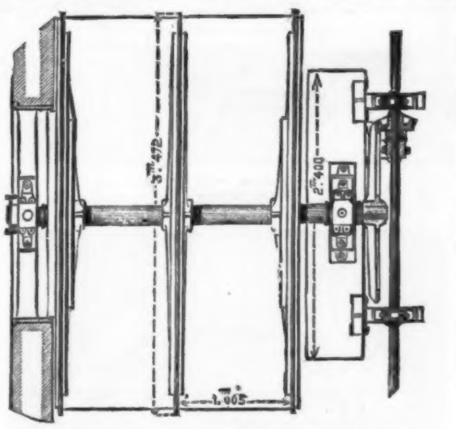


Fig. 7—ECHANGEUR, SECTIONAL PLAN.

another. Each consists of finely perforated sheet iron. They are placed in a trough of water, just sufficiently immersed to insure complete wetting. When rotated at a slow speed, the surfaces of all the cylinders are kept just wetted. A volume of air is either driven or drawn through, as may be required for any particular purpose. In the model malting, as shown at Fig. 4, taken from that shown at the Brewery Exhibition, the air was driven through the *echangeur* and thence through the germinating barley. Here or as employed in the malting illustrated, the air in its passage comes first into contact with the moistened cylinders, and if hot and

The turning apparatus is shown by Fig. 4, and consists, as will be seen, of a cylindrical frame provided with rollers which run on rails at the edge of the germinating cases. It is carried to and fro from either end of the case by compensating rope gearing which at the same time gives motion to the gearing actuating the turning screws. These screws do not quite touch the bottom of the germinating case, but are provided with a pair of small brushes, as shown in the annexed engraving, Fig. 8, which just skim it. The apparatus shown has but three of these screws, but the cases are generally made wide enough for six. The kilns are double, each possessing two floors, and worked upon the Stopes' system. The construction of the furnaces is of the ordinary French pattern. The arrangement of the house permits of great regularity in working. Every day 130 qrs. of barley is screened, sorted, cleaned, and passed into a steeping cistern. When sufficiently steeped it runs through piping into the germinating case, which, in the natural order of working, is empty. Here it forms the couch. When it is desirable to open couch a small amount of air is forced through the grain by opening the trap door connected with the main air channel. This furnishes the growing corn with oxygen, removes the carbonic acid gas, and regulates temperatures of the macs of grain. Later the Saladin turner is put in motion about every eight to twelve hours. The screws in rotating upon their axes are slowly propelled horizontally. They thus effectually turn the grain and leave it perfectly smooth. This turning prevents matting of the roots, the regulation of temperature and exposure to air being effected by means of the cold air from the *echangeur*. When the grain is sufficiently grown it is elevated to the kilns. For forty hours it remains upon the top floor. It is then dropped upon the bottom floor, a further charge of green corn following upon the top floor. The benefit is mutual. The bottom floor is maintained at an even temperature, being virtually plunged in an air bath; free radiation of heat is prevented; the top surface of the malt is necessarily nearly as warm as that next the wires, which in its turn is subject to lower heats than would be necessary if free radiation from the surface was allowed. The top floor is by the intervention of the layer of malt between it and the fire prevented it from coming into direct contact with heat of a dangerous and damaging degree. The same heat which is used to dry one floor, and in an ordinary kiln passes at once into the air as waste, is the best possible description of heat, namely, very slightly moistened heated air, to remove the moisture from the second layer of malt at a low temperature. It is of vital importance to retain this green malt at a low heat so long as any percentage of moisture exceeding, say, 15 per cent. is retained by the corn.

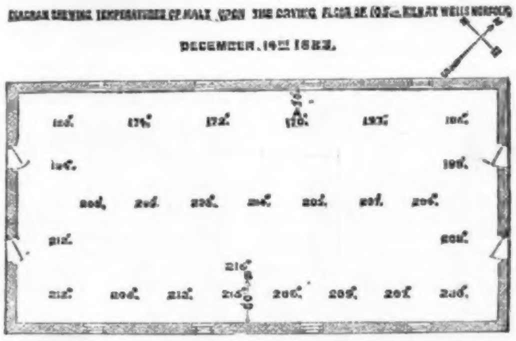
The regulation of temperature is shown by the diagrams, Figs. 9 and 10:

ive metallic surface to air space is thus 9 to 2." The Casella anemometer gave no indications at several points, and fluctuating up and down draughts were observable at many others, especially at two corners and along the center. "The strongest upward draught pulsated with the gusts of wind and ranged from 30 feet to 54 feet per minute, a down draught of equal intensity occurring at intervals at the same spot, notwithstanding the fact that the air was rushing in at the inlets below the floor at the high velocity of 785 feet per minute. The temperatures of the drying malt and superimposed air consequent upon the conditions thus indicated were naturally as follows: At B, the place supposed to be hottest: Heat of malt touching tiles, 216 deg.; heat of malt 1 inch above tiles, 167 deg.; heat of malt 3 inches above tiles 154 deg.; heat of malt 4 inches above tiles, 152 deg.; heat of

Fig. 8.

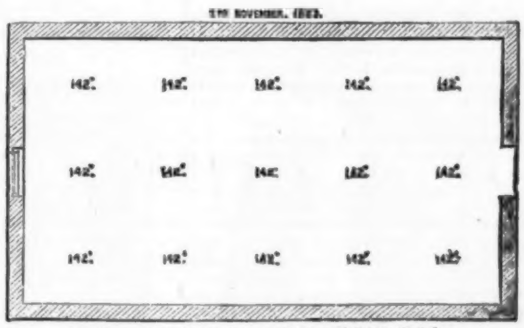
malt 5 inches above tiles, 142 deg.; heat of malt on surface, 112 deg. At A, the place supposed to be coldest: Heat of malt next tiles, 174 deg.; heat of malt 2 inches above tiles, 143 deg.; heat of malt 4 inches above tiles, 135 deg.; heat of malt on surface, 104 deg.; the heat of the air 3 feet above tiles, 84 deg.; the heat of the air 5 feet above tiles, 82 deg. Fig. 9 shows the temperature at twenty-six points close to the tiles, taken with twelve registered and accurate thermometers in the space of fifteen minutes." These and other similar tests have led to the conclusion that the best malt drying cannot be done on a single floor.

Fig. 10 is a similar diagram showing the temperatures on a drying floor of kiln at Poole, Dorset, altered to Stopes' system of drying. The temperature at different depths of the drying grain was as follows: Malt at surface of tiles, 142 deg.; malt at 1 inch above tiles, 142 deg.; malt at 2 inches above tiles, 142 deg.; malt at 4 inches above tiles, 141 deg.; malt on surface, 140 deg



A. SUPPOSED COLDEST POINT + B. SUPPOSED HOTTEST POINT.

Fig. 9



B. Supposed Hottest Point. A. Supposed Coldest Point.

Fig. 10

dry it becomes moist and cool, for the constant evaporation upon the cylinders has a very considerable refrigerating effect.

This was well known to the Egyptians over four thousand years ago, and the porous bottle—*gergeleh*—of Esneh has been made until the present day, to keep the drinking water cool and fresh. The *echangeur* is like a gigantic gergeleh, and by increasing the size and number of the cylinders, and causing the water in the moistening trough to circulate, any volume of air can be wetted to the saturation limit corresponding to its temperature. It will be seen that this apparatus gives the maltster complete control of the humidity and heat as well as volume of the air driven through germinating corn.

The distribution of the heated air in the kiln is rarely as uniform as is supposed, the temperature of the malt on drying floor being very different at different parts. In illustration of this, the following may be taken from a statement by Mr. Stopes of the results of an examination of the temperatures at different parts of a drying floor in a kiln in Norfolk: "A malting steeping 105 qr. every four days has a kiln 75 feet by 36 feet; an average drying area of under 26 feet per qr. The consequent depth of green malt when loaded is over 10 inches. The total area of air inlets is less than 27 feet super. The air outlet exceeds 117 feet, a ratio of 13 to 3. The capacity of head room equals 44,550 feet cube. The area of each tile is 144 inches, with 546 holes, giving an effective air area of some 32 inches. The ratio of non-effect-

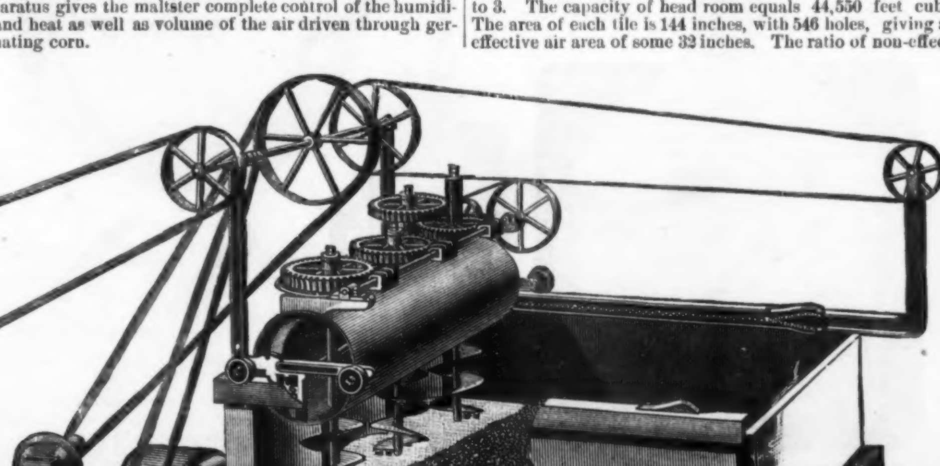


Fig. 4.—ECHANGEUR AND TURNING MACHINE.

The advantages of the Saladin system over that hitherto working in Britain are numerous, and are thus enumerated by Messrs. Stopes & Co. who are agents for M. Saladin: The area occupied by the building does not equal one-third of that otherwise required. The actual growing-floor space is only about one-seventh, and the number of workmen is ruled necessarily by the size of the house, but on an average is reduced two-thirds; but the employment of much more power is necessary, and the power is used at more frequent intervals. The use of plant and premises is continuous, the processes of malting being equally well performed during the summer months. The further advantage of this is that brewers secure entire uniformity in age of malt. By the English system the stocks of finished malt necessarily fluctuate largely. All grain is subjected to the same conditions of surrounding air, exposure, and temperature. The volume of air supplied to the germinating corn is entirely under control, as are also its temperature and humidity. When germination is arrested and the green malt is drying, the double kilns insure control of the temperatures of the corn in the kilns. The infrequency of turning the germinating grain benefits the growth of the roots and the development of the plumule, besides saving much labor. No grains are crushed or damaged by the feet or shovels of workmen. The air supplied to the corn can be inexpensively freed from disease germs and impurities. The capital needed for malting can be reduced by the diminished cost of installation, and the reduced stocks of malt on hand. The quality of the malt made is considerably improved. The percentages of acidity are much reduced. The stability of the beer is increased, and a greater percentage of the extractive matter of the barley is obtainable by the brewer.—*The Engineer.*

NON-SPARKING KEY.

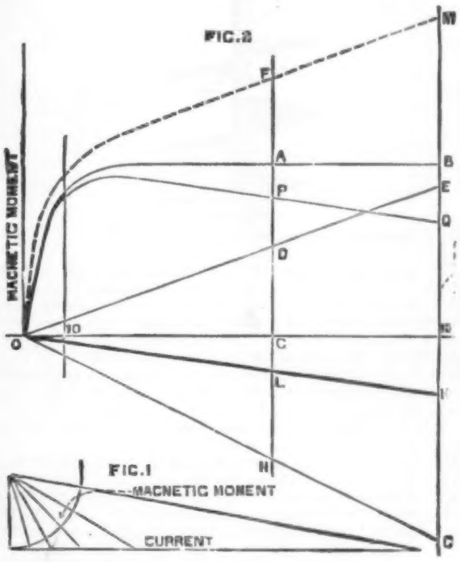
Profs. Ayrton and Perry lately described and exhibited before the Physical Society their new ammeters and voltmeters, also a non-sparking key. The well known ammeters and voltmeters of the authors used for electric light work are now constructed so as to dispense with a constant, and give the readings in amperes and volts without calculation. This is effected by constructing the instruments so that there is a falling off in the controlling magnetic field, and a considerable increase in the deflecting magnetic field. The deflections are thus made proportional to the current or E.M.F. measured. The ingenious device of a core or soft iron pole-piece, adjustable between the poles of the horseshoe magnet, is used for this purpose. By means of an ammeter and voltmeter used conjointly, the resistance of part of the circuit, say a lamp or heated wire, can be got by Ohm's law.

Profs. Ayrton and Perry's non-sparking key is designed to prevent sparking with large currents. It acts by introducing a series of resistance coils determined experimentally one after the other in circuit, thereby cutting off the spark.

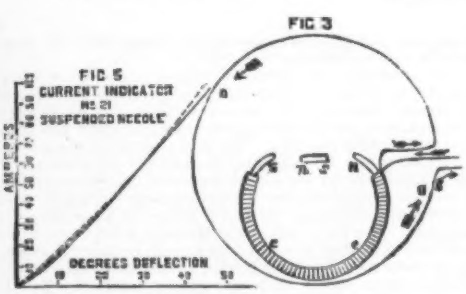
NEW INSTRUMENTS FOR MEASURING ELECTRIC CURRENTS AND ELECTRO-MOTIVE FORCE.

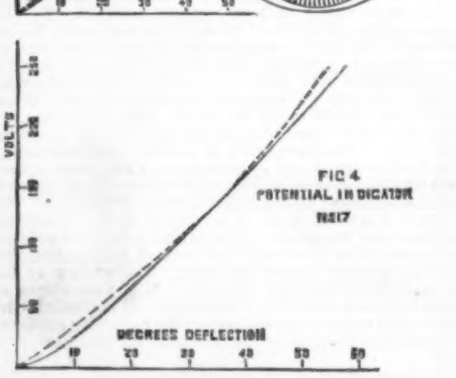
By Messrs. R. E. CROMPTON and GISBERT KAPP.*

IN consequence of the rapid development of that part of electrical science which may be termed "heavy electrical engineering," reliable measuring instruments specially suitable for the large currents employed in lighting and transmission of energy have become an absolute necessity. As usual, demand has stimulated supply, and many ingenious and useful instruments have been invented, the manufacture of which forms at the present day an important industry. Mr. Shoolbred, in a paper which he recently read before

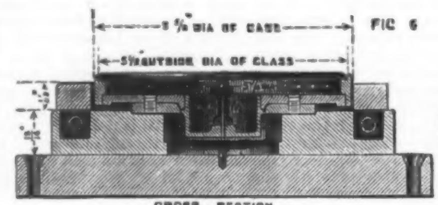


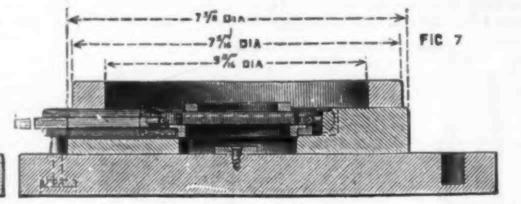
this Society, gave a full and interesting account of the labors of our predecessors in this field. To-day we add to the list then given a class of instruments invented by us, examples of which are now before you on the table. We have preferred to call them current and potential indicators in preference to meters, considering that the latter term, or rather termination, ought to be applied rather to integrating instruments, which the necessities of electric lighting, we believe, will soon bring into extensive use. The principal aim in the design of these indicators has been to obtain instruments which will not alter their calibration in consequence of external disturbing forces. If this object can be attained, then it will be possible to divide the scale of each instrument directly into amperes or volts, as the cause may be, and thus avoid the use of a coefficient of calibration by which the deflection has to be multiplied. This is an important consideration when it is remembered that in many cases these instruments have to be used by unskilled workmen, to whom a multiplication involving the use of demical fractions is a tedious and in some cases even an impossible task.



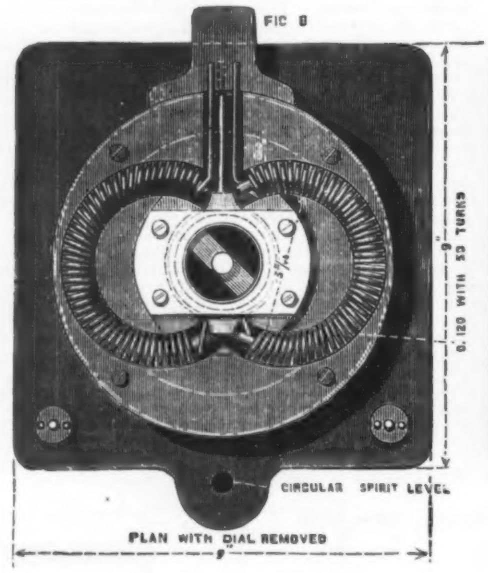


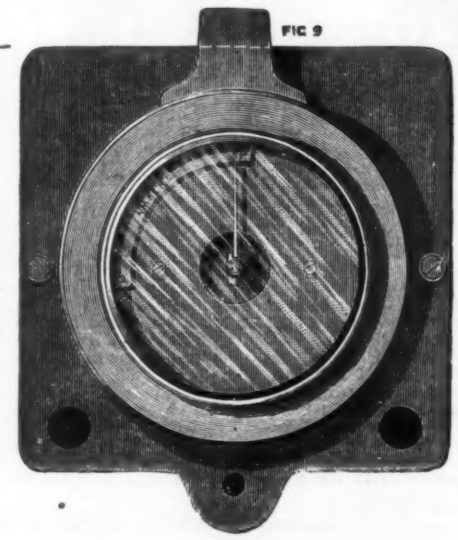
All measurements are comparative. We measure weights or forces by comparison with some generally known and accepted unit standard weights, lengths, areas, and volumes, by comparison with a unit length, resistance by a standard ohm, and so forth. In the same way currents could be measured by comparison with a standard current; but this would be a troublesome process, not only on account of the apparatus necessary, but also because it would be a matter of some difficulty to have a standard current always ready for use. In general, measurement by direct comparison with a standard unit is discarded for the more indirect method of measuring not the current itself, but its chemical, mechanical, or magnetic effect. The chemical method is very accurate if a proper density of current through the surface of the electrodes be used,* but since it requires a considerable time, and, above all, an absolutely constant current, its use is almost entirely restricted to laboratory work and to the calibration of other instruments. For practical ready use, instruments employing the mechanical or magnetic effect of the current are alone suitable. We weigh, so to speak, the current against the force of a magnet, of a spring, or of gravity. The measurement will be exact if the thing against which we weigh or counterbalance the current itself retains its original standard value. Where permanent magnets or springs are used as a balancing force, this condition of constancy in our weights and measures is not always fully maintained, and to make matters worse, there is no visible sign by which a change, should it have occurred, can be readily detected. A spring may have been overstrained or a steel magnet may have become weakened without showing the least alteration in outward appearance. To overcome this difficulty, the obvious remedy is not to use springs or steel magnets at all, but to substitute for these some other force which should be either absolutely constant, such as the force of gravity, or at least should, vary only within narrow limits, and this in accordance with a definite law. This latter condition can be fulfilled by the employment of electro-magnets.





CROSS SECTION

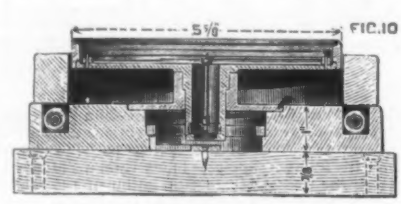




PLAN

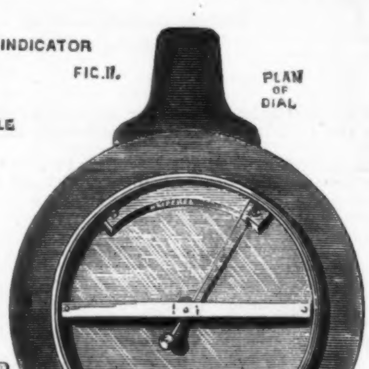
To imitate with an electro magnet as nearly as possible a permanent magnet, so that the former can be used to replace the latter, it is necessary that the magnetism in the iron core should remain constant. This could, of course, be done by exciting the electro magnet with a constant current from a separate source. (In a recent note to the Paris Academy of Science, M. E. Ducretet described a galvanometer with steel magnet, which is surrounded by an exciting coil. When recalibration appears necessary, a known standard current from large Daniell cells is sent through this coil during a certain time, and thus the magnet is brought back to its original degree of saturation. M. Ducretet also mentions the use of a soft iron bar instead of a steel magnet, in which case the current from the Daniell cells must be kept on during the time an observation is taken.) But such a system would appear to be too complicated for ready use. Moreover, some sort of indicator would be required by which we could make sure that the exciting current has the normal strength.

The plan we adopt is to excite the electro magnet by the whole or a part of the current which is to be measured. Since this current varies, the power exciting the core of the electro magnet must also vary; and since we require the core to have as nearly as possible a permanent magnetic force, we are brought face to face with the question, whether an electro magnet can be constructed that has a constant moment under varying exciting currents. This question has been answered by the well known experiments of Jacobi, Dub, Mueller, Weber, and others. To get an absolutely constant magnetic moment is not possible, but between certain limits we can get a very near approximation to constancy.



CROSS SECTION

CURRENT INDICATOR



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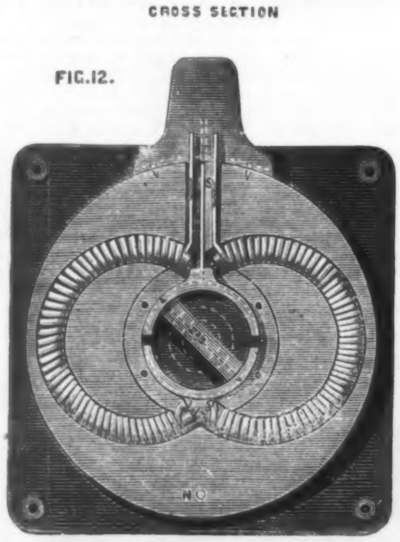
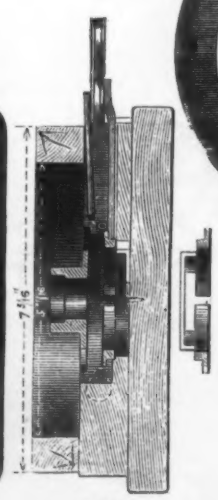


PLAN WITH DIAL REMOVED



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FIC.13 A

SECTION OF SEGMENT

The relation between exciting power and magnetic moment is very complicated, depending not only on the dimensions and shape of the core and the manner of winding, but also on the chemical constitution of the iron of the core. It is not possible, or at least it has hitherto not been found possible, to embody all these various elements into an exact mathematical formula, which would give the magnetic moment as a function of the exciting current; but the above mentioned experiments have shown that within certain limits, and in the neighborhood of the point of saturation, the relation be-

* Paper read before the Society of Telegraph Engineers, 14th February, 1884.

* According to recent experiments made by Dr. Hammerl, the density of current in a copper voltameter should be half an ampere per square inch of surface.

tween the two is that of an arc to its geometrical tangent. It will be seen that for large angles the arc increases much slower than the tangent; that is, for strongly excited cores, a very large increase of the exciting current will produce only a slight increase of magnetic moment. If Mueller's formula were correct for all currents, absolute saturation could only be reached with an infinite current. Whether this be the case or not, it is certain that the greater the exciting current the less will a variation in it affect the magnetic moment of the core. To imitate as nearly as possible permanent steel magnets, it is therefore necessary to use electro magnets, the cores of which are easily saturated. The core should be thin and long and of the horseshoe type; the amount of wire wound round it should be large in comparison with the size of the core.

Here is a magnet partly wound which was used in one of our earliest experiments, but which was a failure on account of having far too much mass in the core in comparison with the amount of copper wire wound round it. Since then we have greatly diminished the iron and increased the copper. The cores of the instruments on the table are composed of two or three No. 18 b.w.g. charcoal iron wires, and are wound with one layer of 0·120 inch wire in the case of the current indicators, and eighteen layers of 0·0139 inch wire in the case of the potential indicator. If from the diagram, Fig. 1, we plot a curve the abscissæ of which represent exciting current, and the ordinates magnetic moment of the soft iron core, we find that a considerable portion of the curve is almost a straight and only slightly inclined line. If it were a horizontal straight line the core would be absolutely saturated, but such as it is, it answers the purpose sufficiently well, for with a variation of exciting current from 10 to 100 amperes the magnetic moment varies but slightly. If a small soft iron or magnetic steel needle, *n s*, be suspended between the poles, S N, of an electro magnet of such proportions as described above, and the current, after exciting the electro magnet, *e e*, be lead round the coils, D D, it will be found that for all currents between 10 and 100 amperes the needle, *n s*, shows a definite deflection for each current. Here we have a galvanometer with permanent calibration. In this case the deflection of the needle will not strictly follow the law of tangents, because the directing power of the electro magnet is not absolutely constant; but whatever the exact ratio between deflection and current may be, it must always remain the same, and to each angle of deflection corresponds one definite strength of current.

The force with which the electro magnet tends to keep the needle in its zero position, that is, in line with the poles, S N, is due partly to the magnetism of the core, which is nearly constant, and partly to the magnetic influence of the coils, *e e*, themselves, which is, of course, simply proportional to the current. The total magnetic force acting on the needle is, therefore, represented by the sum of these two forces, and consequently not nearly so constant as might be desired in order to get a good imitation of a tangent galvanometer with a permanent magnet. In the diagram, Fig. 2, the curve, O A B, represents the magnetic moment of the iron core, the straight line, O D E, that of the exciting coils *per se*, and the dotted line, O F M, the sum of the two, obtained by adding for every current, O C, the respective ordinates, C D and C A.

$$CF = CD + CA.$$

The rise of this curve shows that the force which tends to bring the needle back to its zero position increases with the current, though at a slower ratio than the deflecting force of the current. It follows from this that for large currents the increment in the angle of deflection is comparatively small, and the divisions on the scale whereon the current is to be read off would come too near together to allow accurate readings to be taken. In other words, the range of accurate reading in an instrument so constructed would only be limited. But it is very easy to eliminate the magnetic effect of the coils of the electro magnet on the needle, by introducing an opposite magnetic effect, so that only that part of the force remains which belongs to the soft iron core proper. One way of doing this is by surrounding the needle with a coil, the plane of which is at right angles to the line, S N, and coupling this coil in series with the deflecting coil, D D. If the proportions of this transverse coil and the direction of the current through it be properly chosen, its magnetic effect can be made to exactly counterbalance that of the exciting coils, *e e*, without perceptibly weakening the magnetism of the iron core. But instead of employing two coils, one parallel and the other transversely to the zero position of the needle, we can obtain the same result in a more simple manner with one coil only, if this be placed at such an angle that its magnetic effect can be substituted for the combined effects of the two coils. In other words, we set the deflecting coil, D D, at a certain angle to the zero position of the needle.

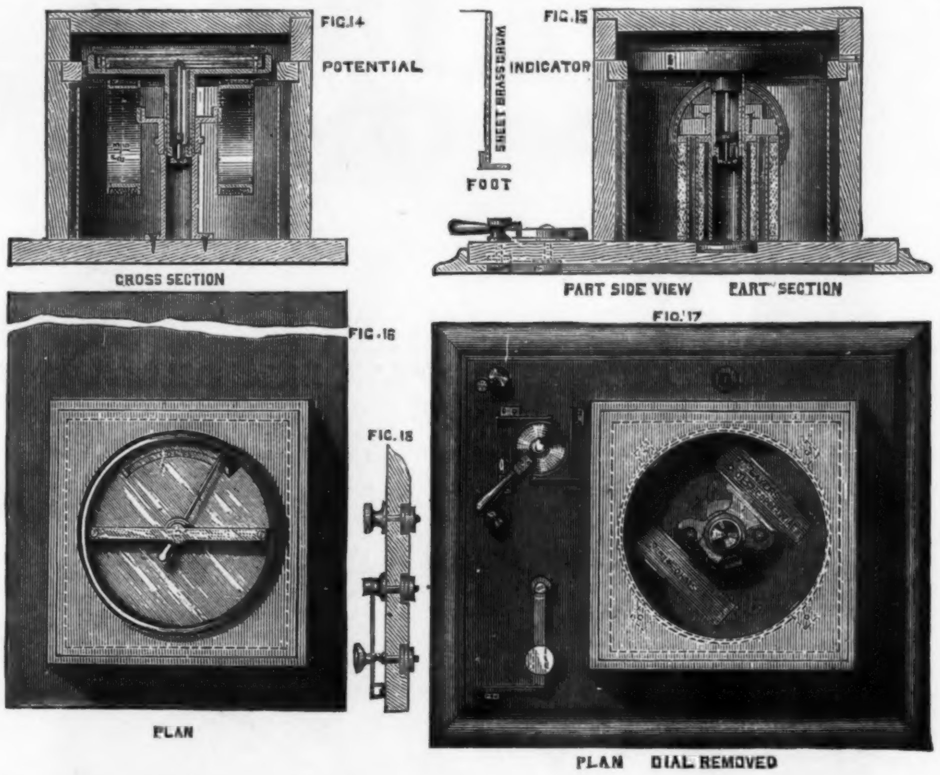
A similar arrangement, though not precisely for the same purpose, has already been suggested and tried by Messrs. Deprez, Carpentier, Ayrton, and Perry, in galvanometers with permanent steel magnets. If the coil, D D, be so placed, the deflecting force which now acts obliquely can be considered as the resultant of two forces, one acting at right angles to the line, S N, as in an ordinary galvanometer, and the other parallel to this line, but in a sense opposed to the action of the electro magnet and its exciting coils. If the angle of obliquity be so chosen that this latter component exactly equals the magnetic effect of the exciting coils *per se*, an equality which holds good for all currents, then we shall have an almost perfect imitation of a tangent galvanometer with permanent magnets. But we can go a step further than this; we can overbalance the exciting coils by setting the deflecting coil at a greater angle than necessary for the mere elimination of the former, and thus attain that an increase of current results in a slight weakening of the field in which the needle swings, thus allowing the increment of the angle of deflection to be comparatively large even for large currents. In this way it is possible to obtain a more evenly divided scale than in the case when the deflection follows the law of tangents as in an ordinary tangent galvanometer. This principle of overbalancing the exciting coils is shown on diagram, Fig. 2. The straight line, O G, represents the magnetic effect on the needle of that component of the deflecting force which is parallel, but in sense opposed to S N; as mentioned above, the magnetic effect of the exciting coils is represented by the straight line, O E. The combined effect of these two forces on the needle is represented by the line, O K, the ordinates of which must be deducted from those of the curve, O A B, in order to obtain the total directing force due to each current. This is shown by the curve, O P Q, shown in a thick full line. This curve shows how the directing force or strength of field in which the needle swings decreases with an increasing current. That this does actually take place can easily be proved by experiment.

Fig. 4 shows two curves; the one drawn in a full line is obtained by plotting the deflection in degrees of the needle of a potential indicator as abscissæ, and the corresponding electromotive forces measured simultaneously on a standard instrument as ordinates; the dotted line shows what this curve would be with an ordinary tangent galvanometer.

The needle of the potential indicator is mounted at the lower end of a steel axle, to the upper end of which is fastened a light aluminum pointer, whereby the deflection of the needle can be read off on a scale divided directly into volts. The scale is placed within a circular dial plate with glass cover, giving sufficient room for the pointer to swing all round, and the needle is placed within a central tube fitting it closely, which acts as a damper and so makes the instrument almost dead beat. Tube and dial are in one casting. The electro magnet is of horseshoe form fastened to a central tubular stand, which also serves to support the two deflecting coils, one on either side of it. The tube within which the magnetic needle swings is inserted into the stand, which is bored out to the external diameter of the tube. The electro magnet and deflecting coils are wound with from 50 to 100 ohms of fine insulated copper wire, and an additional resistance coil of from 450 to 900 ohms of German silver is added, which can, however, be short circuited by depressing a key when the instrument has to be used for reading low electromotive forces. In this case the indication of the pointer must be divided by ten. If a current be sent through the instrument the wrong way, the needle turns through an angle of 180°, and thus brings the pointer to the side of the dial opposite to where the scale is. In this position no reading can be taken, and to facilitate the sending of the current in the right direction a commutator is added, and the same is so coupled up that when the pointer stands over the scale the handle on the commutator points to the positive terminal screw. There is a limit of electromotive force below which the indicator fails to give reliable readings. For instance, an instrument wound with 100 ohms of copper wire and 900 ohms of German silver can be used for electromotive forces varying between 300 and 3 volts, but would not be reliable for measuring less than 3 volts.

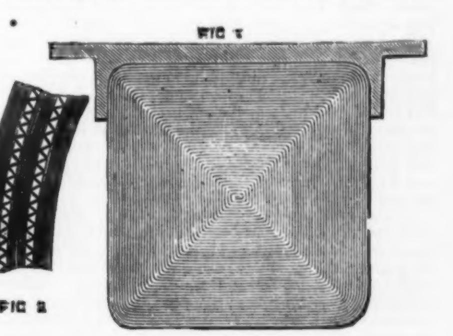
For very exact measurements the instrument should be placed north and south, in the same position in which it was calibrated. Two different patterns of current indicators are on the table; one with double needles suspended on a point in the way compass magnets are suspended, the other with one lozenge shaped needle mounted on an axle and pivoted on jewels, in every way similar to the needle of the potential indicator first described.

For measurements of currents from 10 amperes upward, there is no need to employ a complete coil as the deflecting agent; one half-coil or one strip passing close under the needle gives sufficient deflecting force, and thus the construction of the instrument is rendered extremely simple. The current, after entering at one of the flat electrodes, splits in two parts, each part passing round the winding of an electro magnet of horseshoe form, the similar poles of both magnets pointing toward each other and toward the needle. After traversing the winding, the current unites again, and passes through a metal strip close under the needle, and finally out of the instrument by the other electrode, which lies close under that at which the current entered, but is insulated from it by a sheet of fiber. The metal strip is set at an angle, to balance or overbalance, as may be preferred, the magnetic influence of the exciting coils. The effect of this overbalancing is shown in Fig. 5, where the full curve represents the current as a function of the deflection—obtained by comparison with a standard instrument—and the dotted curve shows what that relation between deflection and current would be if the law of tangents held good for these instruments. It will be seen that, about the middle of the scale, the dotted line coincides nearly with the full line, while at the extreme end of the scale the dotted line is higher. From this follows that if we compare our indicator from which this curve was taken with any form of tangent instrument showing an equal angle of deflection at the medium reading, it will be seen that the needle of our indicator will be deflected to a greater angle at high readings than that of the tangent galvanometer. Consequently, the divisions on the scale will be widest apart in our instruments, which greatly facilitates high readings.



SECONDARY BATTERIES.

THE Consolidated Electric Light Company has now completed the secondary battery which has for some time engaged the attention of its officers, and their regular manufacture and use for electric lighting stations have been fairly entered upon. Among other places to which the batteries have been sent and put into work is Colchester, where the company has for some time had an installation at work, chiefly employing incandescent lamps. The battery consists of lead electrodes, anode and cathode being of the same



character. They are constructed of narrow ribbons of lead, each element being made from long lengths of the ribbon about or nearly 0·20 in. width, rolled together into a flat cake like rolls of narrow webbing, as illustrated by the annexed diagram, Fig. 1, the greater part of the ribbon being very thin and flat; but intermediate thicker ribbons are also employed, as in Fig. 2, this thicker ribbon being corrugated as shown, and affording passage room for the circulation of the electrolyte. From four to eight coils of the plain ribbons are between every pair of corrugated ribbons. They are wound up together tightly, and pressed into the nearly rectangular form shown. The bar for suspending the coil plates so made in the cells is soldered to the coil. The object of this construction is of course to obtain large lead surface, and of course a much larger surface is so obtained than could be practically obtained from plain lead plates in the same compass. A battery thus made may be seen at the offices of the company, 110 Cannon Street.

A very ingenious device for cutting the battery out of circuit when charged as much as is thought desirable is used by the company. In a cell is an element which has a determined lower capacity than those in the rest of the battery. Over this element is placed a gas-tight chamber in which is a diaphragm, this diaphragm being of very flexible material placed in the cover of the box of cells. When charging has proceeded as long as is desirable, or proceeds too fast, hydrogen is evolved, and this collecting in the chamber referred to acts upon the diaphragm, and by means of a rod connected thereto, switches the current, which is supplied to an electro-magnet and by which circuit is made through the medium of mercury contacts. The object of this is to save the battery from destruction by over-charging or charging by too large a current.—*The Engineer.*

ACETYLENE FROM IODOFORM.

P. CAZENEUVE publishes in the *Comptes Rendus* a new method for the preparation of acetylene, which consists in mixing iodoform intimately with moist and finely divided silver. An abundant evolution of acetylene takes place without heating. The reaction is represented by the following formula: $2CHI_3 + 6Ag = C_2H_2 + 6AgI$. The decomposition of the iodoform is hastened if the silver is mixed with finely divided copper, such as can be obtained by precipitating it from its sulphate by means of zinc.

Cazeneuve also observed that most metals which have any affinity for iodine will decompose iodoform in the presence of water, forming acetylene and an iodide of the metal. By the use of zinc he obtained a liquid having a pleasant ethereal odor, and a gas mixture that contained besides acetylene an iodine compound which burned with a purple-edged, fawn-colored flame.

WHEN DOES AN ELECTRIC SHOCK BECOME FATAL?

IN this age of electricity and electric wires carrying currents of various intensity, the question of danger arising from contact with them has caused considerable discussion. An examination into the facts as they exist may therefore enlighten some who are at present in the dark.

To begin with, we often hear the question asked—why is it that certain wires carrying very large currents give very little shock, whereas others, with very small currents, may prove fatal to those coming in contact with them? The answer to this is—that the shock a person experiences does not depend upon the current *flowing in the wires*, but upon the current *diverted from them* and *flowing through the body*.

The muscular contraction due to a galvanic current, which was first observed in the frog, gives a good illustration of the fact that it requires only a very minute current to flow through the muscles in order to contract them. Thus the simple contact of pieces of zinc and copper with the nerves generated current sufficient to excite the muscles—a current which would require a delicate galvanometer for its detection. What is true of the muscles of the frog holds good also for the human muscles; they too are very susceptible to the passage of a current.

In order to determine the current which proves fatal we need only to apply the formula which expresses Ohm's law, viz., $C = \frac{E}{R}$, or the current (ampere) equals the electromotive force (volt) divided by the resistance (ohm).

According to the committee of Parliament investigation, the electromotive force dangerous to life is about 300 volts; this then is the quantity, E, in the formula. There remains now only to determine the resistance in ohms which the body offers to the passage of the current. In order to obtain this, a series of measurements under different conditions were made. On account of the nature of the experiment a high resistance Thomson reflecting galvanometer was used, with the following results.

When the hands had been wiped perfectly dry, the resistance of the body was about 30,000 ohms; with the hands perspiring ordinarily it fell to 10,000 ohms; whereas when they were dripping wet it was as low as 7,000 ohms. Our readers can judge this resistance best when we state that the Atlantic cable offers a resistance of 8,000 ohms.

Taking an ordinary condition of the body, with the hands perspiring as usual, we would have the resistance equal to 10,000 ohms. Applying the two known quantities in the formula, we get:

$$C = \frac{300}{10,000} = \frac{1}{33 \cdot 333+}$$

This means, therefore, that when the electromotive force or potential is great enough to send a current of $\frac{1}{33}$ ampere through the body, fatal results will ensue. This current is so minute that it would deposit only about 6 *grains* of copper in *one hour*, a grain being $\frac{1}{7000}$ of a pound.

Let us now compare these figures with some actual cases, taking as an example a system of incandescent lighting. In these systems the difference of potential between any two points of the circuit outside of the lamps does not exceed 150 volts. Taking this figure, therefore, it will be seen that under no circumstances can the shock received from touching these wires become dangerous—not even by touching the terminals of the dynamo itself; because in neither case can a current be driven through the body, sufficient to cause an excessive contraction of the muscles.

In a system of arc lighting, however, we have to deal with entirely different conditions; for, while in the incandescent system the adding of a lamp, which diminishes the resistance, requires no increase of electromotive force, the contrary is the case in the arc light system. Here every additional lamp added to the circuit means an increase in resistance, and consequent increase in electromotive force or potential. Taking for example a well known system of arc lighting, we find that the lamps require individually an electromotive force of 40 volts with a current of 10 amperes. In other words, the difference in potential at the two terminals of every such lamp is 40 volts. Consequently, if the circuit were touched in two places, including between them only one lamp, no injurious effects would ensue. If we touch the circuit so as to include two lamps between us, the effect would be greater, since the potential between those two points is 2 x 40 volts. We might continue in this manner touching the circuit until we had included about 7 or 8 lamps, when the shock would become fatal, since the point would be reached at which the difference of potential is great enough to send a dangerous current through the body.

Up to this point we have assumed that, while touching two points in the wire, the rest of the circuit is perfectly insulated, so that no current can leak, in other words, that the circuit is nowhere "grounded." If this is not the case we may, under suitable conditions, receive a shock by touching only *one* point of the wire. This becomes clear by considering the current to leak from another spot of different potential, to pass through the ground and into the body; thus, on touching the wire the body virtually makes a connection between the two points of the circuit. In clear dry weather such leaks are insignificant; but in damp and rainy weather, and with poor insulation, they may rise to such a point at which it would be dangerous to touch the circuit even with one hand, the leaks being sometimes so great as to cause the lamps to burn in a fitful, desultory manner, and to go out entirely.

There is still another factor which enters into the discussion of the danger of electric light wires. This must be looked for in the fact that the physiological effects are greatest at the moment of the opening or the closing of the circuit; or in a closed circuit they are the more marked when the flow of current stops and starts, or diminishes and increases. In dynamo electric machines the current is not absolutely continuous or uniform, since the coils on the armature being separated a distance cause a slight break or diminution of the current between each. This break is so short that it does not interfere with the practical work for lighting; in some constructions, nevertheless, the distances apart is so great that, while not interfering with light, its effects upon the muscles are greatly increased over those of other constructions which give a more uniform current.

All these statements might lead to the conclusion that arc light wires are dangerous under any circumstances; but this is not the case. The first and only requisite is, that they be perfectly insulated. When thus protected accidents from them are impossible, and all mishaps that have occurred through them can be traced directly to the lack of insulation. Nevertheless, we would warn our readers against experimenting upon arc wires by actual trial, because unforeseen conditions might lead to disagreeable results.

ROBERT CAUER'S STATUE OF LORELEI.

THE statue of Lorelei, the mythical siren of the Rhine, represented in the annexed cut, which is taken from the *Illustrirte Zeitung*, was modeled by Robert Cauer, of Kreuglach on the Rhine. He was born at Dresden in 1831, and is the son of the well-known sculptor Emil Cauer, and a brother of the sculptor Karl Cauer.

LORELEI STATUE BY ROBERT CAUER.

REDUCING AND ENLARGING PLASTER CASTS.

ORDINARY casts taken in plaster vary somewhat, owing to the shrinkage of the plaster; but it has hitherto not been possible to regulate this so as to produce any desired change and yet preserve the proportions. Hoeger, of Gmuend, has, however, recently devised an ingenious method for making copies in any material, either reduced or enlarged, without distortion.

The original is first surrounded with a case or frame of sheet metal or other suitable material, and a negative cast is taken with some elastic material, if there are undercuts; the inventor uses agar-agar. The usual negative or mould having been obtained as usual, he prepares a gelatine mass resembling the hektograph mass, by soaking the gelatine first, then melting it and adding enough of any inorganic powdered substance to give it some stability. This is poured into the mould, which is previously moistened with glycerine to prevent adhesion. When cold, the gelatine cast is taken from the mould, and is, of course, the same size as the original. If the copy is to be reduced, this gelatine cast is put in strong alcohol and left entirely covered with it. It then begins to shrink and contract with the greatest uniformity. When the desired reduction has taken place, the cast is removed from its bath. From this reduced copy a cast is taken as usual. As there is a limit to the shrinkage of the gelatine cast, when a considerable reduction is desired the operation is repeated by making a plaster mould from the reduced copy, and from this a second gelatine cast is taken and likewise immersed in alcohol and shrunk. It is claimed that even when repeated there is no sacrifice of the sharpness of the original.

When the copy is to be enlarged instead of reduced, the gelatine cast is put in a cold water bath, instead of alcohol. After it has swollen as much as it will, the plaster mould is made as before. For enlarging, the mould could also be made of some slightly soluble mass, and then by filling it with water the cavity would grow larger, but it would not give so sharp a copy.

STRIPPING THE FILM FROM GELATINE NEGATIVES.

WE have frequent inquiries as to the best means of removing a gelatino-bromide negative from its glass support so that it can be used either as a direct or reversed negative, and it does not appear to be very generally known that about two years ago Mr. Plener described a method which answers well under all circumstances, whether a substratum has been used or not.

If a negative is immersed in extremely dilute hydrofluoric acid contained in an ebonite dish, say half a teaspoonful to half a pint of water, the film very soon becomes loosened, and floats off the glass, this circumstance being due to the solvent action which the acid exercises upon the surface of the plate as soon as it has penetrated the film. If the floating film be now caught upon a plate which has been slightly waxed, and it is allowed to dry on this plate, it will become quite flat and free from wrinkles. To wax the plate, it should be held before the fire until it is moderately hot, after which it is rubbed over with a lump of wax, and the excess is polished off with a piece of flannel. When the film is dry, it will leave the waxed glass immediately, if one corner is lifted by means of a penknife. The film will become somewhat enlarged during the above-described operation; but, by taking suitable precautions, this enlargement may be avoided. It is also convenient to prepare the hydrofluoric acid extemporaneously by the action of sulphuric acid on fluoride of sodium; and, in many cases, it is advisable to thicken up the film by an additional layer of gelatine.

The following directions embody these points. The negative, which must be unvarnished, is leveled, and covered with a layer of warm gelatine solution (one in eight) about as thick as a sixpence. This done, and the gelatine set, the plate is immersed in alcohol for a few minutes in order to remove

the greater part of the water from the gelatinous stratum. The next step is to allow the plate to remain for five or six minutes in a cold mixture of one part of sulphuric acid with twelve parts of water, and in the mean time two parts of sodium fluoride are dissolved in one hundred parts of water, an ebonite tray being used. A volume of the dilute sulphuric acid equal to about one-fourth of the fluoride solution is next added from the first dish, and the plate is then transferred to the second dish, when the film soon becomes liberated. When this is the case, it is placed once more in the dilute sulphuric acid. After a few seconds it is rinsed in water, and laid on a sheet of waxed glass, complete contact being established by means of a squeegee, and the edges are clamped down by means of strips of wood held in position by American clips or string. All excess of sulphuric acid may now be removed by soaking the plate in methylated alcohol, after which it is dried. It is as well to add a few drops of ammonia to the last quantity of alcohol used.

The plate bearing the film negative is now placed in a warm locality, under which circumstances a few hours will suffice for the complete drying of the pellicular negative, after which it may be detached with the greatest ease by lifting the edges with the point of a penknife.—*Photo. News.*

NEW ANALOGY BETWEEN SOLIDS, LIQUIDS, AND GASES.

By W. SPRING.

THE author asks in the first place, What is the cause of the different specific gravities of one and the same metal according as it has been cast, rolled, drawn into wire, or hammered? Does the difference observed prove a real condensation of the matter under the action of pressure, or is it merely due to the expulsion by pressure of gases which have been occluded when the ingot was cast? According to well-known researches, metals such as platinum, gold, silver, and copper, which have been proved to occlude gases on fusion, and to let them escape, *incompletely*, on solidification, are precisely those which are most increased in their specific gravity by pressure. The author has submitted to pressures of about 20,000 atmospheres metals which possess this property, either not at all, or to a very trifling extent, and he finds that though a first pressure produces a slight permanent increase of density, its repetition makes little difference. Their density is found to have reached a maximum. Hence the density of solids, like that of liquids, is only really modified by temperature. Pressure effects no permanent condensation of solid bodies, except they are capable of assuming an allotropic condition of greater density. The author's former researches tend to show that solid matter, in suitable conditions of temperature, takes the state corresponding to the volume which it is compelled to occupy. Hence there is an analogy between the allotropic states of certain solids and the different states of aggregation of matter. Possibly the different forms of matter may be due to a single cause—polymerization. The limit of elasticity of a solid body is the critical moment when the matter begins to flow under the action of the pressure to which it is submitted, just as, *e. g.*, ice at or below 0° may be liquefied by strong pressure. A brittle body is simply one which does not possess the property of flowing under the action of pressure.

HYDROGEN AMALGAM.

HYDROGEN, although a gas, is recognized by chemists as a metal, and when combined with any solid metal—as in the case known to electricians as the polarization of a negative element,—the compound may correctly be termed an alloy; while any compound of hydrogen with the fluid metal mercury may with equal correctness be termed an amalgam of hydrogen, or "hydrogen amalgam." The efforts of many chemists and mining engineers have for many years been devoted to a search for some effective and economical means for preventing the "sickening" of mercury and its consequent "flouring" and loss. Some sixteen or more years ago, Professor Crookes, F.R.S., discovered and, after a series of experiments, patented the use of an amalgam of the metal sodium for this purpose. He made the amalgam in a concentrated form, and it was added in various proportions to the mercury used for gold amalgamation. Water becoming present, it will readily be understood that the sodium, in being converted into the hydrate (KHO) of that metal, caused a rapid evolution of hydrogen. The hydrogen thus evolved was the excess over a certain proportion which enters into combination with the mercury. While the mercury retained the charge of hydrogen, the "quickness" of the fluid metal was preserved; but upon the loss of the hydrogen the "quickness" ceased, and the mercury was acted upon by the injurious components contained in the ore.

Since the introduction of the sodium amalgam, many attempts have been made, more especially in America, to overcome the tendency of mercury to "sicken" and lose its "quickness." The greater number of these efforts have been made by the use of electricity as the active agent in attaining this end; but such efforts have been generally of a crude and unscientific character. Latterly Mr. Barker, of the Electro-amalgamator Company, Limited, has introduced a system—already detailed in these pages—by which the mercury is "quickened." In his method the running water passing over the tables, or other apparatus of a similar character, is used as the electrolyte. In this arrangement, the mercury being the cathode, plates or wires of copper constituting anodes are brought into contact with the water passing over the mercury in each "riffle." Both the cathode and the anodes are, of course, maintained in contact with the poles of a suitable source of electrical supply. The current then passes from the copper anode through the running water to the mercury cathode, and so on to the negative pole of the electro-motor. As a consequence of this arrangement, hydrogen is evolved from the water, and has the effect of reducing any oxide or other detrimental compound of the metal; in other words, it "quickens" and prevents "sickening" of the fluid metal, and consequent "flouring" and loss. While the hydrogen is evolved at the cathode, oxygen enters into combination with the copper constituting the anodes. This to some extent impairs the conductivity of the circuit.

The latest process, however, is that of Mr. Bernard C. Molloy, M.P., which we have already characterized as highly scientific and effective, the production of a suitable amalgam being obtained under the most economical and simple conditions. This process has the advantage of producing not only a hydrogen amalgam, but also at will an amalgam of hydrogen combined with any metal electro-positive to this latter. Thus hydrogen potassium or hydrogen sodium can be obtained, as will be seen by the following description.

Mr. Molloy's effort appears to have been, in the first place, directed to a system which could be adapted to any existing apparatus, and in certain cases where water was scarce, to avoid altogether the use of that, in some districts, rare commodity. For the purpose of explanation we select an ordinary amalgamating table fitted with mercury riffles. The surface of the table is in no way interfered with or disturbed. The bed of the riffle, however, is constructed of some porous material, such as leather, non-resinous wood, or cement, which serves as the diaphragm upon which the mercury rests, and separates the fluid metal from the electrolyte beneath. Running the full length of the table is a thin layer of sand, supported and pressing against the diaphragm, and lying in this sand is the anode, formed preferably of lead. A peroxide of that metal is formed by the action of the currents, and may be readily reduced for use over and over again after working for from one to three months. The peroxide of lead, as is well known, is a conductor of electricity, and this fact constitutes an important advantage in the working of the process. The thin layer of sand is saturated with an electrolyte, such as dilute sulphuric acid ($H_2SO_4 + 20H_2O$) to give a simple hydrogen amalgam; ($Na_2SO_4 + xH_2O$) to give a hydrogen sodium amalgam; or ($K_2SO_4 + xH_2O$) to give a hydrogen potassium amalgam. Numerous other electrolytes constituted by acids, alkalies, and salts can be used to form an amalgam permanently maintained in a condition of "quickness" and freed from all liability to "sicken," whatever the components of the ore may be. The mercury is connected with the negative pole of the voltaic battery or other electro-motor, and the lead made with the positive pole of the same source. When the current passes there is formed according to the nature of the electrolyte, a hydrogen amalgam, or an amalgam of hydrogen with a metal electro-positive to hydrogen. The electrolyte, which, it will be understood, is distinct and apart from the body of water passing over the table, will last almost indefinitely, there being no consumption of any of its constituents, excepting hydrogen and oxygen from the water of solution. The quantity of acid or saline material contained in the electrolyte is so very small that there can be no difficulty in finding a supply in any district. The question of the supply of electricity is one which in many mining districts involves considerations of practical importance, since a large supply would necessitate water or steam power. It has been found that two cells having an electro-motive force of about two volts each will in this process suffice; if preferred, however, a very small dynamo machine can be used. In connection with the electro-motive force it is requisite to use, it may be observed that an amalgam of sodium containing only a small quantity of this metal would, when constituting a positive element in conjunction with a lead negative and on an aqueous electrolyte, give an opposing electro-motive force of less than three volts. Such an amalgam could therefore be obtained under an electro-motive force of about four volts. The electrical resistance in the circuit constituted by the apparatus being very small, no electrical power is wasted. When water constitutes the electrolyte, as in Barker's system, then the electro-motive force required to obtain a given current would be very much greater than that above specified. The conditions assured under this process appear to be all that can be required, while the amalgams obtained are those most calculated to preserve the "quickness" and prevent the "sickening" of the mercury.

Mr. Molloy has designed a special form of amalgamating machine to be used in conjunction with the above process, and with or without the aid of water. By the employment of this machine, each particle of the ore is slowly rolled in the quickened mercury for from fifteen to thirty or more seconds.

When the extent of the gold and silver mining industries is considered, and when it is borne in mind that a considerable percentage of the precious metal present in the ore is, in the ordinary process of extraction, lost through defective amalgamation—due to insufficient contact with the mercury or to a total absence of contact, as in the case of float gold—it is obvious that the introduction of any system obviating such loss is a matter of very great importance to those who are interested in the above mentioned industries. We expect shortly to hear of the practical introduction on a large scale of Mr. Molloy's process, and we look forward with interest to the results which may be obtained from it.—*The Engineer.*

TREATMENT OF ORES BY ELECTROLYSIS.

By M. KILIANI.

THE author lays down general principles for electrolytic metallurgy. Ores must be distinguished as good and bad conductors; the former may serve directly as anodes, and are easily oxidized by the electro-negative radicals formed at their contact, and dissolve readily in the electrolyte. The bad conductors have to be placed in contact with a conducting anode, formed of an inoxidizable substance, such as platinum, manganese peroxide, or coke. In laboratory experiments a good conducting ore is electrolyzed by suspension from a platinum wire in connection with the source of electricity, and is then immersed in the bath. On an industrial scale the ore, coarsely broken up, is placed in one of the compartments of a trough divided by a diaphragm.

On the fragments of the ore which extend up outside of the electrolytic bath is laid a plate of copper connected with the positive wire. Care must be taken that this plate does not plunge into the bath, otherwise the current would not traverse the ore at all. The cathode is preferably formed of the same metal which is to be obtained. The bath should not contain organic acids. In practice the common mineral acids are employed, or their salts, selecting by preference a salt of the metal which is to be isolated. It is convenient to pass the current through the greatest possible number of small decomposition troughs, taking care that the resistance in each is not too great. With a current of one and the same intensity we obtain in *n* troughs *n* times as much metal as in a single one. To keep down the resistance of the circuit we employ poles of a large surface, *i. e.*, plenty of ore and baths which are as good conductors as possible.

The state in which the metal is deposited at the negative pole depends on the secondary actions undergone by the electrolyte, and especially of the escape of gas. This is a function of the *density*, of the current, *i. e.*, the proportion of its intensity to the surface of the cathode. If the density is too great there is an escape of hydrogen, and the metal is deposited in a spongy condition. If the density of the current falls below a certain minimum, an oxide is deposited in place of metal. The electrolytic treatment of ores often renders it possible to separate the different metals which may be present. These are deposited in succession, and are sharply separated if the electromotive power is not too great.

1. *Zinc.*—The zinciferous compounds—calamine, blende, and zinc ash—are all poor conductors. They are first dissolved, and the salts obtained are electrolyzed, employing anodes of coke. Blende should be roasted before it is dissolved. The electrolytic bath should be as concentrated as possible to avoid sponginess of the metal and an escape of hydrogen. In a saturated solution the formation of hydrogen decreases as the density of the current augments.

2. *Lead.*—Galena is a good conductor, and may be directly electrolyzed. The best bath is a solution of lead nitrate. The arborescent crystallizations extend rapidly, and must be broken from time to time to prevent the formation of a metallic connection between the anode and the cathode. The sulphur of the galena falls to the bottom of the bath, and may be separated from the gangue by solution in carbon disulphide.

3. *Copper.*—Native copper sulphide, though a good conductor, cannot be directly electrolyzed on account of the presence of iron sulphide, whence iron would be deposited along with the copper. The copper pyrites are roasted, dissolved in dilute sulphuric acid, and the liquid thus obtained is submitted to electrolysis.

A PEOPLE WITHOUT CONSUMPTION, AND SOME ACCOUNT OF THEIR COUNTRY—THE CUMBERLAND TABLELAND.

By E. M. WIGHT, M.D., Chattanooga, Tenn., Late Professor of Diseases of the Chest and State Medicine, Medical Department University of Tennessee; Late Member of the Tennessee State Board of Health, and ex-President of the Tennessee State Medical Society.

DURING the ten years that I have practiced medicine in the neighborhood of the Cumberland Tablelands, I have often heard it said that the people on the mountains never had consumption. Occasionally a traveling newspaper correspondent from the North found his way down through the Cumberlands, and wrote back filled with admiration for their grandeur, their climate, their healthfulness, and almost invariably stated that consumption was never known upon these mountains, excepting brought there by some person foreign to the soil, who, if he came soon enough, usually recovered. Similar information came to me in such a variety of ways and number of instances, that I determined some four years ago, when the attempt to get a State Board of Health organized was first discussed by a few medical men of our State, that I would make an investigation of this matter. These observations have extended over that whole time, and have been made with great care and as much accuracy as possible, and to my own astonishment and delight, I have become convinced that pulmonary consumption does not exist among the people native and resident to the Tablelands of the Cumberland Mountains.

In the performance of the work which has enabled me to arrive at this conclusion, I have had the generous assistance of more than twenty physicians, who have been many years in practice in the vicinity of these mountains. Their knowledge of the diseases which had occurred there extended over a period of more than forty years. Some of these physicians have reported the knowledge of the occurrence of deaths from consumption on the Tablelands, but when carefully inquired into they have invariably found that the person dying was not a native of the mountains, but a sojourner in search of health. In answer to the question: "How many cases of pulmonary consumption have you known to occur on Walden's Ridge, among the people native to the mountains?" eleven physicians say, "Not one." All of these have been engaged in practice there more than three years, four of them more than ten years, one of them more than twenty, and one of them more than forty years. All the physicians of whom inquiries have been made are now residents, or have been, of the valleys contiguous to Walden's Ridge, and know the mountain people well. Four other physicians in answer to the same question say, that they have known from one to four cases, numbering eleven in all, but had not ascertained whether five of them were born and raised on the mountains or not. The names and place of death of all these cases were given, and I have traced their history and found that but three of them were "natives," or had lived there more than five years, and that one of these was 57 years of age when she died, and had suffered from cancer for three years before her death. The two others died within six months after returning home from long service in the army, where both contracted their disease.

All these investigations have been made with more particular reference to that part of the Cumberlands known as Walden's Ridge than to the mountains as a whole. This ridge is of equal elevation and of very similar character to the main Cumberland range in the southern part of Tennessee, northwest Georgia, and northwest Alabama, and what is true of this particular part of the great Cumberland table is, in the main, true of the remainder.

Sequatchee Valley lies between Walden's Ridge and what is commonly known in that neighborhood as the Cumberland Mountains, and separates it from the main range for a distance of about one hundred miles, from the Tennessee River below Chattanooga to Grassy Cove, well up toward the center line of the State. Grassy Cove is a small basin valley, which was described to me there as a "sag in the mountains," just above the Sequatchee Valley proper. It is here that the Sequatchee River rises, and flowing under the belt of hills which unites the ridge and the main range, for two miles or more, rises again at the head of Sequatchee Valley. Above Grassy Cove the mountains unite and hold their union firmly on their way north as far as our State reaches.

Topographically considered as a whole, the Cumberland range has its southern terminus in Alabama, and its northern in Pennsylvania. It is almost wholly composed of coal-bearing rocks, resting on Devonian strata, which are visible in many places in the valleys.

But a small portion of the Cumberland lies above a plane of 2,000 feet. Walden's Ridge and Lookout Mountain vary in height from 2,000 to 2,500 feet.

North of Grassy Cove, after the ridges are united, the variation from 2,000 feet is but little throughout the remainder of the State, and the general character of the table changes but little. The great and important difference is in the climate, the winters being much more severe in these mountains in the northern part of the State than in the southern, and the summers much more liable to sudden changes of weather. Scott, Fentress, and Morgan counties comprise this portion of the table, and these have not been included in my examination, excepting as to general features.

In all our southern country, and I may say in our whole country, there is no other large extent of elevated territory

which offers mankind a pleasant living place, a comfortable climate—none too cold or too hot—and productive lands. We have east of the upper waters of the great Tennessee River, in our State, and in North Carolina and Georgia, the great Blue Ridge range of mountains, known as the Unaka, or Smoky, Chilhowee, Great and Little Frog, Nantahala, etc., all belonging to the same family of hills. This chain has the same general course as the Cumberlands. It is a much bolder range of mountains, but it is vastly less inhabitable, productive, or convenient of access. The winters there are severely cold, and the nights in summer are too cold and damp for health and comfort, as I know by personal experience of two summers on Nantahala River. But the trout fishing is beyond comparison, and that is one inducement of great value for a stout consumptive *who is a good fellow*. These mountains are much more broken up into branches, peaks, and spurs than the Cumberlands. They afford no table territory of any extent. There are some excellent places there for hot summer visits—Ashville, Warm Springs, Franklin, and others.

The Cumberland Mountains, as a whole, are flat, in broad level spaces, broken only by the "divides," or "gulfs," as they are called by the inhabitants, where the streams flow out into the valleys.

Walden's Ridge, of which we come now to speak particularly, is the best located of any part of the Cumberlands as a place for living. From the separation of this ridge from the main range of Grassy Cove to its southern terminus at the Tennessee River, it maintains a remarkably uniform character in every particular. From it access to commerce is easy, having the Tennessee River and the new (now building) Cincinnati Southern Railroad skirting its entire length on the east. It rises very abruptly from both the Tennessee and Sequatchee Valleys, being from 1,200 to 1,500 feet higher than the valleys on each side. Looking from below, on the Tennessee Valley side, the whole extent of the ridge appears securely walled in at the top by a continuous perpendicular wall of sandstone, from 100 to 200 feet high; and from the Sequatchee side the appearance is very similar, excepting that the wall is not so continuous, and of less height.

The top of the ridge is one level stretch of plain, broken only by the "gulfs" before mentioned and an occasional prominent sandstone wall or bowlder. The width on top is, I should judge, 6 or 7 miles. The soil is of uniform character, light, sandy, and less productive for the ordinary crops of the Tennessee farmer than the soil of the lowlands. The grape, apple, and potato grow to perfection, better than in the valleys, and are all never failing crops; so with rye and buckwheat. Corn grows well, very well in selected spots, and where the land is made rich by cultivation. The grasses are rich and luxuriant, even in the wild forests, and when cultivated, the appearance is that of the rich farms of the Ohio or Connecticut Rivers, only here they are green and growing the greater part of the year; so much so that sheep, and in the mild winters the young cattle, live by the wild grasses of the forests the whole year. The great stock raisers of the Sequatchee and Tennessee Valleys make this the summer pasture for their cattle, and drive them to their own farms and barns or to market in winter. The whole Cumberland table, with the exception of that small part which is under cultivation, is one great free, open pasture for all the cattle of the valleys. Thousands of cattle graze there whose owners never pay a dollar for pasturage or own an acre of the range, though, as a rule, most of the well-to-do stock farmers in the valleys own more or less mountain lands. These lands have, until quite recently, been begging purchasers at from 12½ to 25 cents per acre in large tracts of 10,000 acres and upward, and perhaps the same could be said of the present time, leaving out choice tracts and easily accessible places, which are held at from 50 cents to $2 per acre, wooded virgin lands.

The forest growth of Walden's Ridge is almost entirely oak and chestnut. Hickory, perhaps, comes next in frequency, and pine after. There is but little undergrowth, and where the forests have never been molested there are but few small trees. This is due to the annual fires which occur every autumn, or some time in winter, almost without exception, and overrun the whole ridge. It does not rage like a prairie fire. Its progress is usually slow, the material consumed being only the dry forest leaves and grasses. The one thing essential to its progress is these dry leaves, hence it cannot march into the clearings. Nearly all the small shrubs are killed by these fires, otherwise they are harmless, and are greatly valued by the stock men for the help they render in the growth of the wild grasses. The free circulation of air through these great unbroken forests is certainly much facilitated by these fires, since they destroy every year what would soon become impediments. The destruction of this undergrowth leaves the woods open, and the lands are mainly so level that a carriage may be driven for miles, regardless of roads, through the forests in every direction.

The shrubs about the fields and places where the forests have been interrupted by civilization and other causes are blackberry, huckleberry, raspberry, sumac, and their usual neighbors, with the azalia, laurel, and rhododendron on the slopes and in the shade of the cliffs.

The kinds of wild grasses, I regret to say, I have not noted, and the same of the rich and varied display of wild flowers.

The whole ridge is well supplied with clean, soft running water, even in the driest of the season. There are no marshes, swamps, or bogs, no still water—not even a "puddle" for long—for the soil is of such a character, that surface water quickly filters away into the sands and mingles with the streams in the gulfs. Springs of mineral water are abundant everywhere. Probably there is not a square mile of Walden's Ridge which does not furnish chalybeate water abundantly. Sulphur springs with Epsom salts in combination are nearly as common.

The entire extent of Walden's Ridge is underlaid with veins of coal, and iron ore is plentiful, especially in the foot hills. The coal and iron are successfully mined in many places on the eastern slope; on the western they are nearly untouched for the want of transportation. I find that the impression prevails that the minerals of the Cumberlands are largely controlled by land agents and speculators. This is only true as applied to a very small part of the whole, not more than 1 per cent. The mineral ownership remains with the lands almost entirely.

The prevailing winds on Walden's Ridge are from the southwest; northers and northeasters are of rare occurrence. One old lady who had resided there for forty years, in answer to my query upon this subject, said: "Nine days out of ten, the year round, I can smell Alabama in the air." This was the usual testimony of the residents. Winds of great velocity never occur there. In summer there is always an evening breeze, commencing at 4 to 6 o'clock, and continuing until after sunrise the next morning. In times of rain, clouds hang low over the ridge occasionally, but they never have fogs there.

The range of the thermometer is less on the Tablelands than in the adjacent valleys. I have had access to the carefully taken observations of the Lookout Mountain Educational Institute, such published accounts as have been made by Professor Safford, State Geologist, Mr. Killebrew, the thorough and painstaking private record of Captain John P. Long, of Chattanooga, and many more of less length of time. From all these I deduce the fact that the summer days are seven or eight degrees cooler on the mountains than in the Tennessee Valley at Chattanooga, and five or six degrees cooler than in the Sequatchee Valley, as far up as Dunlay and Pikeville. The nights on the table are cooler than in the lower lands by several more degrees than the days; how much I have thus far not been able to state. The late fall months, the winter, and early spring are not so much colder than the valleys as the summer months, the difference between the average temperature of the mountains and valleys being at that time four or five degrees less than in the summer. There is no record of so hot a day ever having occurred on the Cumberland Mountains as to cause mercury to run so high as 95° F., or so cold a day as to cause it to run so low as 10° below zero.

In the average winter the ground rarely freezes to a greater depth than 2 or 3 inches, and it remains frozen but a few days at a time. Ice has been known to form 8 inches thick, but in ordinary winters, 3 or 4 is the maximum. Snow falls every winter, more or less, and sometimes remains for a week. Old people have a remembrance of a foot of snow which lasted for a week.

Walden's Ridge has a total population of a little more than 4,000, scattered over 600 square miles of surface. The number of dwellings is about 800. Ninety per cent. of these are log houses; 70 per cent. of them are without glass windows; light being furnished through the doorways, always open in the daytime, the shuttered window openings, and the open spaces between the logs of the walls. Less than 2 per cent. of these houses have plastered walls or ceilings, and less than 5 per cent. have ceiled walls or ceilings. About 20 per cent. of them are fairly well chinked with clay between the logs, the remainder being but indifferently built in that particular. Fully 90 per cent. of these abodes admit of free access of air at all times of day and night, through the floors beneath as well as the walls and roof above. It is the custom of the people to guard against the coldest of days and nights by hanging bed clothes against the walls, and many good housewives have a supply of tidy drapery which they keep alone for this purpose.

Wood, always at hand, is the only fuel in use. The whole heating apparatus consists in one large open fireplace, built of stone, communicating with a large chimney outside the house at one end, and frequently scarcely as high as the one story building which supports it. This chimney is constructed in such a manner as to be a great ventilator of the whole room, quite sufficient, it would be thought, if there were no other means of ventilation. It is usually made of stone at the base, and that part above the fire is of sticks laid upon one another, cobhouse fashion, and plastered over inside and between with similar clay as that with which the house walls are chinked.

Very few of these houses are more than one story high. They are all covered with long split oak shingles—the people there call them "boards"—rifted from the trunks of selected trees. There is no sheathing on the roof beneath these shingles. They are nailed down upon the flat hewn poles running across the rafters, at convenient distances. Looking up through the many openings in the roof in one of these house, one would think that this would be but poor protection against rain, but they rarely leak.

Not one family in fifty is provided with a cooking stove. They bake their bread in flat iron kettles, with iron covers, covered with hot coals and ashes. These they call ovens. The meat is fried, with only the exception of when accompanied by "turnip greens."

The question, "What is the principal food of the people who live on these mountains?" has been asked by me several hundred times. The almost invariable answer has been, "Corn bread, bacon, and coffee." Occasionally biscuits and game have been mentioned in the answers. All food is eaten hot. Coffee is usually an accompaniment of all three meals, and is drunk without cream and often without sugar. Some families eat beef and mutton for one or two of the colder months in the year on rare occasions, though beef is commonly considered "onfit to go upon," as I was told upon several occasions, and mutton sustains less reputation. Chickens are used for food while they are young and tender enough to fry, on occasions of quarterly meetings, visits of "kinfolks" or the "preachers" and the traveling doctors. Fat young lambs are plenty in many settlements from March to October, and can be had at fifty cents each, but I could not learn that one was ever eaten.

A large majority of the adult population use tobacco in some shape—the men by chewing or smoking, the women by smoking or dipping snuff. They never have dyspepsia, nor do they ever get flesh, after they pass out of childhood, though nearly all the children are ruddy in appearance, and well rounded with fat.

One physical type prevails among the people in middle life, and carries along into old age but little change; and old age is common there. Nearly every house has its old man or old woman, or both. Everybody, father and mother, and frequently grandfather and grandmother, is still on hand, looking as brisk and moving about as lively as the newer generations. After they pass their forty years, they never seem to grow any older for the next twenty or thirty, and the grandfathers and grandmothers can scarcely be selected, by comparison, from their own children and grandchildren. The men are taller than the average, and the women, relatively, taller than the men. They are all thin featured, bright eyed, long haired, sharp looking people, with every appearance of strength and power of endurance.

I think the men who live on Walden's Ridge can safely challenge the world as walkers—aborigines and all; and unless the challenge should be accepted by their own women folks, I feel quite sure they would "win the boots." They go everywhere on foot, and never seem to tire.

Nearly all the people of the Tablelands are employed in the pursuits of agriculture. Very few of them seem to be hard workers. The men are all great lovers of the forest sports, much given to the good, reliable, old fashioned long rifles. The women and children are much employed in out door occupations, and live a great portion of their time in the open air. The clothing of all classes is scanty. The use of woolen fabrics for underwear has not yet been introduced, and coarse cotton domestic is the universal shirting, and cotton jeans, or cotton and wool mixed, constitute the staple for outer wearing apparel. The men wear shoes throughout the year much more commonly than boots. They never wear gloves, mittens, scarfs, or overcoats, and they scorn umbrellas. Probably this whole 4,000 people do not possess two dozen umbrellas or twice as many overcoats. The women go about home with bare feet a great part of the summer. They never wear corsets or other lacing.

I have learned by careful inquiry that very few of the people of the Ridge have ever had the diseases of childhood. Scarlet fever I could hear of in but two places, and I suppose that not one person in fifty has had it. Whooping cough and measles have occurred but rarely, and the large majority have not yet experienced the realities of either. Very few people there have ever been vaccinated, nor has smallpox ever prevailed. Typhoid, typhus, and intermittent fevers are unknown. In the great rage of typhoid fever which took place ten or twelve years ago in the Tennessee and Sequatchee Valleys, not a single case occurred on the Mountains, as I have been informed by physicians who were engaged in practice in the neighborhood at the time. Diphtheria has never found a victim there; so of croup. Nobody has nasal catarrh there, and a cough or a cold is exceedingly rare.

I have said that these observations refer more particularly to Walden's Ridge than to the Cumberland Tablelands in our State as a whole. This ridge was chosen by me for this examination, mainly for the reason of its convenience, but partly owing to its being more generally settled than any other equal portion of the table which lies in Tennessee. Lookout Mountain is not as well located; it is on the wrong side of the Tennessee River, and but a few acres of it belong in this State. Sand Mountain is altogether out of the State, but it is perhaps nearer like Walden's Ridge in its physical features than Lookout. That part of the Cumberlands west of Sequatchee Valley is Walden's Ridge in duplicate, excepting that it is further west, and nearer the Middle Tennessee basin. There are some small towns, villages of miners, and summer resorts there, which interferes with that evenness of the distribution of population which Walden's Ridge has, rendering it more liable to visitations of epidemic and contagious diseases. The tablelands north of the center line of the State, above Grassy Cove, are very similar to Walden's Ridge, as far up as Kentucky, with the exception before mentioned—that of climate—it being from one to ten degrees colder in winter.

This whole Cumberland Table is no small country. It comprises territory enough to make a good sized State. At present, it is almost one great wilderness, in many particulars as unknown as the Black Hills. It is coming into the world now, and will be well known in a few years. The great city of Cincinnati has determined to build a railroad through the very center of this great table in the north part of the State, connecting with Chattanooga in the southern part. This road is nearly bored through, and in another year or two the Cumberland Tablelands in Tennessee will be much heard of at home and abroad.

It seems to me this country has merits. It is located in the latitude of mild climate; not so far south as to be scorched by the hot summer sun, or visited by the great life destroying epidemics; not so far north as to meet the severe and lengthened winters.

Climate, we know, is a fixture; it has a government; it has rules; the weather may change, but climate does not; it is a permanent out-door affair, and what is true of to-day was true centuries ago, and will be true forever, in the measure of any practical scope, at least. The people of the world are beginning to know that the greatest destroyer of human life has its remedy in climate.

Mr. Lombard, in his famous exhibit in relation to the prevalence of consumption among the people of different occupations, circumstances of life, and place of dwelling, gives the lowest number of deaths from this cause to those who live in the open air. He found the people who lived most in the open air, as would be readily conjectured, in the mild latitudes, not in the countries of hot sands or cold snows.

[The above article, in regard to which we have noticed frequent allusions in many of our exchanges, all erroneously attributing it to *Dr. Wright*, of Tennessee, and for which we have received repeated requests quite recently, was read by the lamented Dr. E. M. Wight at the 43d annual meeting of the Tennessee State Medical Society, held at Nashville, April 4, 5, and 6, 1876. Its distinguished and talented author will long be remembered as one of the most active, earnest, and zealous members of the State Society. At this meeting he also read a very admirable paper on "The Microscopic Appearance of the Blood in Syphilis," and prepared the report of the Committee on State Board of Health, to which report may be ascribed the honor of securing the necessary legislation organizing the Board. A true, upright, honest man, an earnest, devoted and zealous physician, universally esteemed and beloved by all who knew him; himself the subject of tuberculosis, dying in the prime of a brilliant manhood. He had but few equals in the glorious profession he honored and loved so well.

From a careful reading of his paper, we find that he describes a large area of territory, free, absolutely free, from subsoil moisture, a climate mild and equable, a soil capable of producing nearly everything necessary for the comfortable maintenance of human life, surroundings that tempt, nay, compel the greatest possible amount of open air life. His description is exceedingly accurate of a plain, primitive, simple-minded people with but few wants, many of the virtues and few of the vices of humanity. With their surroundings, soil, climate, residence, and mode of living, need we be surprised that "there is a people," or a land "free from consumption"?—Ed.]—*Southern Practitioner.*

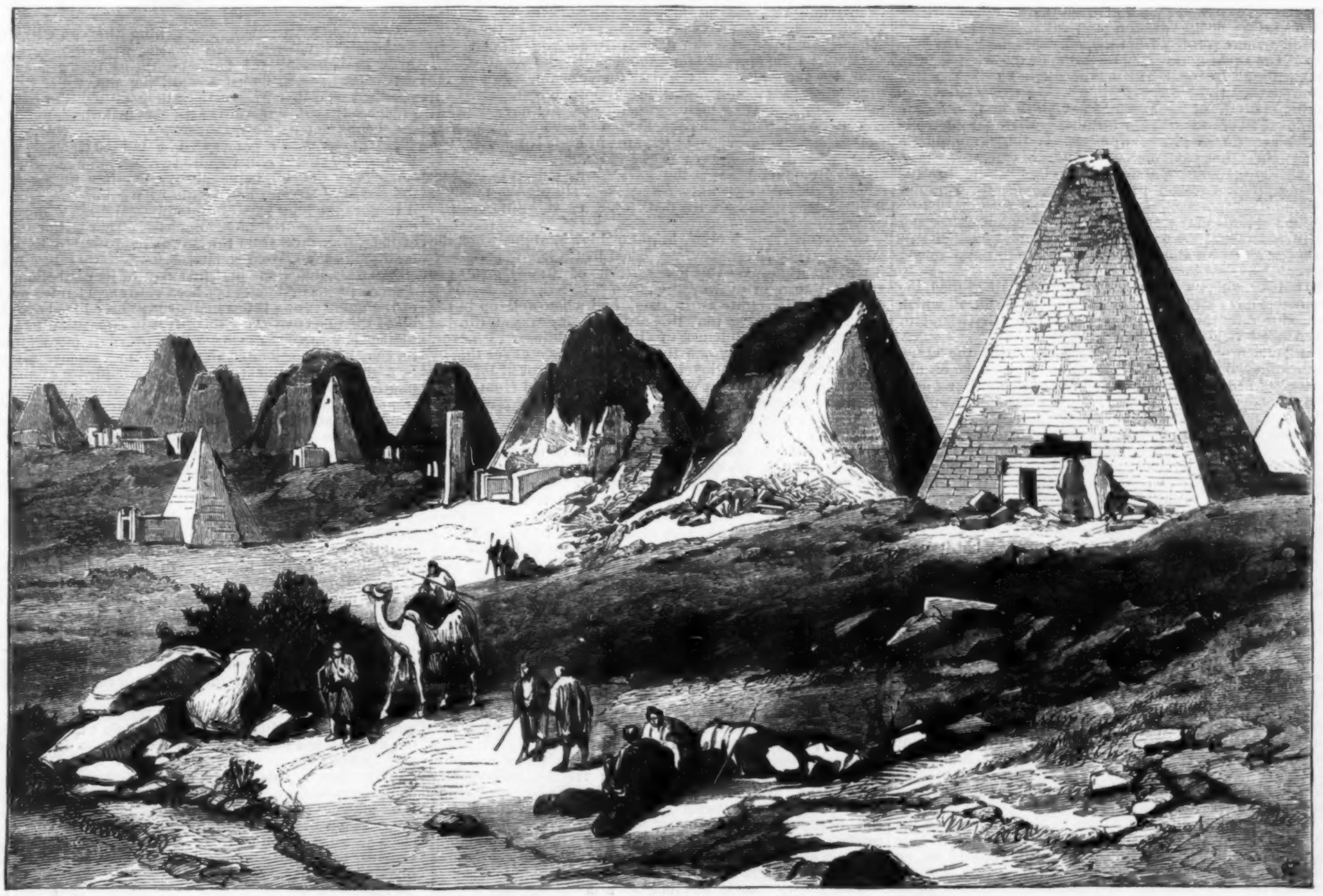
THE TREATMENT OF HABITUAL CONSTIPATION.

Dr. F. P. Atkinson thus writes in the *Practitioner*, January, 1884: I suppose there is no derangement of the system we are more frequently called upon to treat than habitual constipation; and though all kinds of medicines are suggested for its relief, they rarely produce more than temporary benefit—and it is difficult to see how the result can well be otherwise, while the root of the evil remains untouched. Now by far the more numerous subjects of this disorder are women; and as they do not seem to know that regularity is essential to the performance of every one of nature's operations, they appoint no stated times for trying to get the bowels relieved, but trust to receiving intimation when the rectal accumulation and distension can be borne no longer. This method of action may and does answer fairly well for a time; but nature gradually gets upset, the sensation of the lower bowel becomes blunted, and at last it ceases to respond to the ordinary stimulus. Then aperients are regularly resorted to, and although these act fairly well for a time, they gradually have to be increased in strength and frequency. Now, as regards the treatment, the first thing to be accomplished is of course to get the rectum well relieved; the next, to get the actions to take place at fixed times; and lastly,

it is necessary to get more tone imparted to the muscular tissue of the bowels, so that the regularity of action may be helped and also maintained. In order, then, to get the bowels relieved in the first instance, it is well to give five grains of both compound colocynth and compound rhubarb pill at bed-time (this rarely requires to be repeated), then to take a tumblerful of cold water the next morning on waking, and repeat it regularly at the same time each day. Should the bowels remain sluggish for some time, the same quantity of water may be taken daily before each meal. Supposing no action takes place on rising or shortly after, a small injection of warm water may be resorted to. After each movement of the bowels, a small hand-ball syringeful of *cold* water should be thrown into the rectum and retained. A soup plateful of coarse oatmeal porridge (made with water and taken according to the Scotch method, viz., by filling half the spoon with the hot porridge and the other with cold milk) each night at bed-time, or even every night and morning for a time, is often a very great help. But above all things, it is necessary for the patient to *try* and get relief at a certain *fixed* time regularly every day. If these directions are strictly carried out in their entirety, the evil, even if it has been of long standing, will generally be corrected, and the patient will improve in health and appearance. Of course where the constipation results from exhaustion of the nervous system (such, for instance, as is brought about by self-abuse), the special cause has to be taken into consideration, and such treatment adopted as is suited to the particular necessities of the case.

THE PYRAMIDS OF MEROE.

ABOUT fifty miles from the mouth of the Atbara, and, of course, on the eastern bank of the Nile, stand the pyramids of Meroe. They consist of three groups, and there are, in all, about eighty pyramids. The presumption is that they represent the old sepulchers of the kings of Meroe. Candance, Queen of the Ethiopians, mentioned in Acts, chap. viii., v. 27, is supposed to have belonged to Meroe, that being the name also of the capital, which is understood to have been somewhere not far distant from the sepulchers. These pyramids of Meroe possess one marked feature, distinguishing them from the pyramids of Egypt proper—that is, they have an external doorway or porch. As there is no entrance to the pyramid at these porticoes, it is quite possible that they were temples for worship or making offerings to the dead. By comparing them with the pyramids of Ghizeh, it will be seen that they are also taller in proportion to their base. Another important point in these porches or temples is the existence of the arch; and that, too, an arch in principle, with a keystone.—*Illustrated London News.*



THE PYRAMIDS OF MEROE, ON THE NILE.

THE PROLIFICNESS OF THE OYSTER.

IN an article by Prof. Karl Mobius on "The Oyster and Oyster Culture," reproduced in the recently issued report of the U. S. Commissioner of Fish and Fisheries, the author says:

A mature egg-bearing oyster lays about one million of eggs, so that during the breeding season there are upon our oyster beds at least 2,200,000,000,000 young oysters, which surely would suffice to transform the entire extent of the sea-flats into an unbroken oyster bed; for if such a number of young oysters should be distributed over a surface 74 kilometers long by 22 broad, 1,351 oysters would be allotted to every square meter. But this sum of 2,200,000,000,000 young oysters is undoubtedly less than that in reality hatched out, for not only do those full-grown oysters which are over six years of age spawn, but they begin to propagate during their second or third year, although it is true that the young ones have fewer eggs than those which are fully developed. At a very moderate estimation, the total number of three to six year old oysters which lie upon our beds will produce three hundred billions of eggs. This number added to that produced by the five millions of full grown oysters would give for every square meter of surface not merely 1,351 young oysters, but at least 1,535. In order to determine how many eggs oysters produce, they must be examined during their spawning season. This begins upon the Schleswig-Holstein beds in the middle of June, and lasts until the end of August or beginning of September. The spawning oyster does not allow its ripe eggs to fall into the water, as do many other mollusks, but retains them in the so-called beard, the mantle, and gill-plates until they become little swimming animals. The eggs are white, and cover the mantle and gill-plates as a semi-fluid, cream-like mass. As soon as they leave the generative organs the development of the germ begins. The entire yolk-mass of the egg divides into cells, and these cells form a hollow, sphere-like body, in which an intestinal canal arises by the invagination of one side. Very soon the beginnings of the shell appear along the right and left sides of the back of the embryo, and not long afterward a ciliated pad, the velum, is formed along the under side. This velum can be thrust out from between the valves of the shell at the will of the young animal, and used by the motion of its cilia as an organ for driving food to the mouth, or in swimming as a rudder. During these transformations the original cream-white color of the germ changes into pale gray, and finally into a deep bluish-gray color. At this time they have a long oval outline, and are from 0·15 to 0·18 of a millimeter in breadth. Over 300,000 can find room upon a square centimeter of surface. If an oyster in which the embryos are in this condition is opened, there will be found upon its beard a slimy coating thickly loaded with grayish-blue granules. These granules are the embryo oysters, and if a drop of the granular slime be placed in a dish with pure sea water, the young animals will soon separate from the mass, and spread swimming through the entire water. When the embryos are at this stage their number may be estimated in the following manner: The whole mass of embryos is carefully scraped from the beard of the mother oyster by means of a small hair brush. The whole mass is then weighed, and afterward a small portion of the mass. This small portion is then diluted with water or spirits of wine, and the embryos portioned out into a number of small glass dishes, so that they can be placed under the microscope and counted. Thus, knowing the weight of the small portion and the number of embryos in it by count, we can estimate the total number of embryos from the weight of the entire mass, which is also known. In this manner I estimated the number of embryos in each of five full grown Schleswig-Holstein oysters caught in August, 1869, and found that the average number was 1,012,956.

Notwithstanding this great fecundity, but an extremely small proportion of the young oysters produced during the course of the summer arrive at maturity, 421 only out of 500,000,000 escaping destruction. The immolation of a vast number of young germs is the means by which nature secures to a few germs the certainty of arriving at maturity. In order to render the ideas of germ-fecundity and productiveness more easily understood, Prof. Mobius makes the following comparison between the oyster and man:

According to Wappaus, for every 1,000 men there are 34·7 births. According to Bockh, out of every 1,000 men born 554 arrive at maturity, that is, live to be twenty years or more of age; thus, on an average, 34·7 children are produced from 554 mature men, or 62·6 children from 1,000 mature men. Since 1,000 full-grown oysters produce 440,000,000 of germs, then the germ fecundity of the oyster is to the germ fecundity of man as 440,000,000 to 6.26, or as 7,028,754 to 1. On the other hand, the number which arrive at maturity is 579,002 times as great with mankind as with the oyster; for of 1,000 human embryos brought into the world 554 arrive at maturity, or of 440,000,000 newly born 243,760,000 would live to grow up, while of 440,000,000 young oysters only 421 ever become capable of propagating their species. The proportion is then 421 to 243,760,000, or as 1 to 579,002. I am fully persuaded that these figures represent the number of oysters which arrive at maturity more favorably than is really the case, since from every thousand of full grown oysters it is certain that, on an average, more than 440,000,000 young are produced.

RED SKY.

THE beautiful red sky which has been so frequent of late, morning as well as evening, has excited much comment. The comment, however, has consisted more of description, statement of fact, theory, and wonder as to cause, rather than as to satisfactory explanation.

Facts in the case which would reveal the secret of this beautiful display of nature are not complete and numerous enough at present to establish the cause of this phenomenon on a sure basis; yet enough facts, it would seem, have been obtained to satisfy the strong mind capable of bridging over a wide expanse.

Facts in an argument are like piers to a bridge—the more we have of them, *c. p.*, the more substantial the structure. When the facts are *legion*, the structure becomes a causeway, and there is no need of argument.

Argument is a bridge—the fewer the facts, the more the necessity for the bridge; the less the facts, the more argument necessary to connect the few we have, and the more skill is required to make substantial connecting links between the few solid piers (facts) that exist.

One of the queer things in connection with this is, the public have looked chiefly, if not wholly, to the astronomers for an explanation of this phenomenon, when it is not their special province to explain matters in this department of nature.

The explanation belongs to the department of meteorology, and not to astronomy. But the fact of having looked to the astronomers shows how little the world knows of meteorology and how few meteorologists there are able, ready, and willing to rise and explain in face of the opposition of the public, who seem to think that the explanation must necessarily belong to astronomy. Astronomy proper deals with the position of the earth in space and its relation to the other heavenly bodies, whether suns, fixed stars, planets, satellites, comets, or other bodies in the vast space about us. Meteorology deals with the atmosphere of the globe, in all its forms. Astronomy could be studied in the early ages; its grand facts were not wholly dependent upon the advanced condition of the mechanic arts; it could be studied even without the aid of telescopes, though telescopes have added much to its advancement. Meteorology, on the contrary, depended on the advancement of the arts and sciences; they must first be perfected ere we could know much about this branch of science. To one unfamiliar with the advancement and perfection of meteorology within the past ten years, this statement may seem strange, yet it is an undisputable fact that, prior to the establishment of the daily weather reports, the knowledge on this subject amounted to very little, and was not even worthy of being designated a science. Prior to the advent of the weather map the world was in absolute ignorance of the laws governing the atmosphere. Sure, we had had large volumes on the laws of storms, but the

later revelations leave them shelved high and dry on the shores and as useless as a wreck in a similar condition; with the daily weather map before us we have no need to even open these huge volumes; they are completely circumvented, and only negative in value—to show how little was known of the subject without the full and complete facts daily collected and spread before us on the map published by the Weather Bureau.

In order to understand the color of our sky, we must understand the subject which is so immediately connected with it and its creation.

The earth is a sphere in space; generally speaking, it is composed of land and water. These are two factors; the heat that it derives from the sun forms a third factor; the three—land, water, and heat—are essential to life, at least the higher conditions of life which culminate in man. The old physical geography taught us this much, but it was not able to go further and tell us why it was cold or warm independent of the seasons; it could not explain why it was at times as warm, and even warmer, half-way to the pole than at the equator; why it was at times very warm in the extreme northeast while very cold in the Southern States; cold in the northwest when it was warm in the northeast, and warm in the northwest when cold all along the upper Atlantic seaboard; it could not forewarn us of storms. These and a host of other facts, which the weather map makes as plain as astronomy demonstrates that Jupiter is a planet, the new revelation, through the instrumentality of the perfected telegraph system, makes exceedingly plain to us if we will but seek the easily obtained information.

The principal revelations of the weather map are the facts in regard to the areas of high and low barometer, and the influence they exert upon the climate of the globe.

These conditions—high and low barometer—move on general lines from the west towards the east, or towards the rising sun, and around the world in irregular belts. The centers of low barometer are various distances apart, from a thousand to two thousand and even more miles apart—call the average about two thousand miles.

The clouds are formed from the moisture present by the action of the sun's heat. The direction of the wind is from the area of high barometer to that of low. The nearer the winds approach the center of "low" (low barometer), the more they partake of the lines of the volute curve, or curve of the sea shell or water in a whirlpool. High barometer is the atmospheric hill; low barometer is the atmospheric valley. But time at present will not permit more than these general statements; a close study of the weather map for a season will reveal the beautiful minor details.

To the reader it may seem a long way round, yet in order to fully understand the nature of the atmosphere which surrounds our globe we must pay due attention to these newly discovered physical laws.

The red sky which was so noticeable, in the fall of 1883, the astronomers have told us was due to "meteoric dust" which was produced by the volcanic eruption on the island of Java, August 27, 1883.

This "meteoric dust" they say combined with the atmosphere, followed it around the earth, and caused the beautiful redness of the sky at morning and evening. For one, I do not believe dust of any description in the atmosphere would produce such an effect.

There is nothing luminous, transparent, or delicate about dust. Dust would not remain in the atmosphere for months, it would settle in a very short time, and if thick enough in the atmosphere to obstruct the light of the sun it would be visible, discernible, to the eye, and manifest on the face of nature. Years ago, before the age of the weather map, we might have thought that the atmosphere followed the surface of the earth like the water on a grindstone, but it does not. As already seen, the wind is from the area of high barometer to that of low, and there are many of these "low centers."

From the best calculation we can make at present, there would be at least some six centers on an average between the center of the United States and the island of Java. In addition to this there would also be a number of belts of "low" centers, which would complicate the thing threefold at least. At all these different centers the winds would be blowing from all points of the compass at the same time. Such winds would not be apt to bring the "meteoric dust" from Java to the United States, either in an easterly or westerly direction. But, it is said, "dust" has been gathered.

How high from the surface of the ground has this *dust* been gathered—at what elevation?

There is undoubtedly a little dust in the air most of the time, but I do not think that it extends very high. Where it would be the highest and most perceptible would be on the arid plans of Africa and Asia, when the *simoom* is passing, or in the track of a tornado. But from the multiplicity of these storm centers and the varied winds they would produce even this dust could not travel from Java to America.

Again, all clouds, no matter how high or how low, are affected by the low centers, as the movement of clouds prove, and travel from the "high" to the "low," from and to all points of the compass. High authority gives the heights of the clouds as follows: lower clouds, 16,000 feet; upper clouds, 23,000 feet.

As all clouds, from the highest to the lowest, are affected by the centers as above referred to, it follows that if this "meteoric dust" follows the earth around, as it would have to do in order to make good this theory, it would have to travel suspended in the atmosphere above the upper clouds, or at a height of more than 23,000 feet, or at an elevation of over four miles!

Now, is it reasonable to believe that dust, however fine, will remain in the atmosphere at that elevation for over six months?

As a side argument it is suggested that the smoke of the burning woods, or few years ago in Michigan, caused as peculiar condition of the atmosphere. This extensive fire was on a day when the area of low barometer was on a high line of latitude and passing to the eastward. This naturally took the smoke, which is far lighter than dust, along with it. It mingled with the muggy condition of an extensive "low," and produced a yellowness of the atmosphere. This however was of only a few hours' duration, and was only visible in favorable localities.

Here again we see the advantage of the weather maps; but for this map we would never have been able to have satisfactorily explained the peculiar phenomenon produced by the great Michigan fire.

If the delicate redness of the sky is not caused by dust, what is it caused by?

But for the weather map, I think we should still be in the dark in regard to it.

In the first place, this redness is nothing new, only the conditions are more favorable sometimes than at others. It has always existed and always will exist, independent of earthquakes, volcanoes, etc. Nature is ever changing; the movements of the atmosphere more resemble the kaleidoscope than anything else.

The summer and fall of 1883, the movements of "high" (high barometer) over the United States were quite central and extensive, causing this peculiar phenomenon over a wide extent of territory.

We have no information of the condition of the barometer over the other part of the world; we speak more particularly of the United States; yet if certain conditions produce certain effects here, it is quite safe to say that the same effects are produced by the same cause elsewhere.

As now well established by the map, the surface wind is from the area of high barometer to that of low—from the atmospheric hill to the atmospheric valley.

The tendency of this is to free "high" of all clouds and moisture; but then it is impossible to free "high" entirely of moisture; a little will remain, and it is just this little, which is highly rarefied, that produces the result. We look around us and above, we see little or no evidence of evaporation, yet it is the while going on. When the sun is immediately below the horizon, where it will shine horizontally through the mass of light, suspended moisture, the delicate presence of vapor heretofore unnoticed is revealed. The action of the sun's rays is the same as when illuminating a well formed cloud—it is an embodiment of the same principle, but the material is much more expanded. The particles of suspended moisture are very fine, few and far between, therefore the effect of the light upon it is more diffused and transparent. It is much like looking through a piece of window glass flatwise and endwise; flatwise we do not perceive any color; endwise, from seeing through a greater mass, the glass has a very perceptible green color.

We see the same idea also in the rising and setting sun and moon. On a clear, cloudless night, when nothing seems to interfere with the brightness of the stars, we cannot, by looking upward, perceive any moisture present in the atmosphere; but if we cast our eyes to the horizon, whereby we see through the mass of atmosphere endwise, as it were, and note the appearance of the stars there, or the rising or setting moon, we will see that the atmosphere there gives a redness to the rising body, which it does not have when it has ascended to mid-heaven. On a clear night, which is caused by the presence of the area of high barometer, the moon when in mid-heaven is of a clear, silver-white, and it is the same moon that at the horizon was a deep red. The color of the moon has not changed; it is simply the medium through which it is seen that produces the difference in color.

Occasionally, on a clear, bright ("high") night, when the moon is full, prior to rising, when just below the horizon, it will so illuminate this lower strata of atmosphere as to appear like a great fire; the moon rises red, but its deep color gradually fades as it rises, and when well up in the heavens we perceive that this deep coloring was an illusion and merely the influence of its surroundings. I never, though, knew of any one to attempt to account for this by "meteoric dust;" and yet it is an embodiment of the same principle. Place the sun where the moon is, and from its far superior abundance of light we have a much grander display.

Under no other conditions or relations of the sun and earth is it possible to have this phenomenon of the delicate red sky but when a positive area of high barometer is passing and extends over us. In order to produce this effect we must have the clear atmosphere of high barometer, when there is a minimum of moisture present. The action of the sun's rays upon this extensive area of slightly moist rarefied air is unconfined by clouds, and reaches far and wide, and produces a delicacy of color which from no other source or condition can be realized.

ISAAC P. NOYES.

Washington, D. C., 1884.

A THEORY OF COMETARY PHENOMENA.

To the Editor of the Scientific American:

The following subject, substantially, was written more than a year ago with a view to its publication. It was not, however, until January of the present year that I sent a brief communication to the *Brooklyn Eagle*, which was published Feb. 3, giving my views in relation to cometary phenomena. With this I might remain satisfied, were it not that the interesting paper by G. D. Hiscox, published in the SCIENTIFIC AMERICAN SUPPLEMENT, Feb. 16, impressed me with the idea that the theory I advanced might assist in explaining others, if brought to the notice of those interested through the columns of your valuable journal.

The theory that I advance to account for the several phenomena relating to comets' tails is, that comets are nonluminous, transparent bodies; that they transmit the light of the sun; that the transmitted light reflected by the particles of matter in space constitutes the tails of comets. "Like causes produce like effects." By contraries, then, like effects must be produced by similar causes; for, if an effect produced by a cause which is known is similar to an effect produced by a cause which is not known, the cause which is known must be similar to the cause which is not known. This is true or not.

I submit the following experiments to substantiate the theory advanced.

Partially fill a vial or a tumbler with water, hold it by the rim, and move it around a lighted candle placed upon a table. A shadow surrounding the transmitted light will be cast upon the table. As the tumbler approaches the light, the shadow follows the tumbler, and when receding the tumbler follows the shadow; and as the tumbler is moved around the light, the shadow will swing round from one side to the other. If the tumbler be held so that a puff of smoke can be blown into the transmitted rays, the particles of smoke will reflect the transmitted light, and will illustrate my idea of what constitutes a comet's tail. A dark band may be observed in this stream of light, as also in the light cast upon the table.

In these experiments, we see the effects produced by a cause which is known; the effects are similar to those observed in the tails of comets, the cause of which we do not know; but is it not reasonable to assume that the cause is similar?

Assuming now that comets are transparent, can any other phenomena peculiar to comets be accounted for upon this hypothesis? Next to the tail itself, the curve is the most noticeable feature, and if we consider the extraordinary length of these appendages, the astounding velocity at which comets move in their orbits, and the time that would elapse before a ray of light, emitted from the nucleus, would reach the end of the tail, perhaps the curve—which, if I am not deceived in my observations, always dips toward its orbit—can be accounted for. If a comet moved in a direct line toward the center of the sun, there would be no curve to the tail. But taking Donati's comet of 1858 as an example, the tail of which was said to be about 200,000,000 miles long, a ray of light traveling at the rate of 192,000 miles per second would be about twenty minutes in going from the nucleus to the end of the tail.

But during that time the comet would move in its orbit, say, 50,000 miles, and as light moves in a straight line, and other rays are constantly emerging from the nucleus as it moves along in its course, the result is that the tail has a curved appearance.

I have no data at hand regarding this comet, but what I have said will serve to illustrate my ideas. Again, referring to this comet, I remember to have read the statement of an astronomer that, after passing round the sun, a new tail was formed opposite the original one. Now, it seems to me that that is just what would happen, for in moving round the sun the comet would travel say 3,000,000 miles; the greater portion of the tail then would extend millions of miles upon one side of the sun, while from the nucleus upon the opposite side of the sun a new tail would appear to be formed.

Upon this hypothesis, the extraordinary length of their tails and the fact that stars are visible through the densest portion of them is explained; as also the fact that they so rapidly disappear from view when moving from the sun, the light received by them from the sun being in proportion to their distance from it, and but little of that reflected.

JOHN M. HUGHES.

Brooklyn, N. Y.

[FOR THE SCIENTIFIC AMERICAN.]

ON COMETS.

WHEN we see a comet approaching the sun with its tail following in the orbit of the nucleus, we have no great difficulty in believing the common theory that a comet consists of nucleus attracted toward the sun, while the tail is repelled; and that we see the whole of it. But as it approaches the sun, difficulties arise that make us doubt whether the theory be true.

Let us suppose a comet with a tail 50,000,000 miles in length, and that it will require two days to pass round the sun. Now the tail, being always in a line drawn through the center of the sun and center of the nucleus, will, when it reaches the long axis of the elliptical orbit, stand perpendicularly to the orbit of the nucleus. That is, the extremity of the tail farthest from the sun, in addition to its onward motion, has acquired a lateral motion that has lifted it 50,000,000 miles in the first day of its perihelion. The velocity of the extremity has been vastly accelerated over that of the nucleus, and it has moreover a sheer lift above the orbit of the nucleus. Now this lift is in opposition to gravity; neither is it in consequence of any previous momentum, for its velocity is accelerated and its previous momentum would be a hinderance; nor is the lift in consequence of any repelling force from the sun, for such force would be diminished in proportion to the square of the distance, and the far end would be acted on less than the nucleus end of the tail, whereas the velocity of the former is increased a hundred fold over that of the latter. A polar force in the comet would merely draw the comet into the sun. We therefore find no force adequate for such a lift, but on the contrary all the forces are opposed to it.

But if the first day of the perihelion overwhelms us with difficulty, the second day will prove disastrous to the common theory. For the extremity of the tail farthest from the sun will be required to pass with lateral motion from its perpendicular 100,000,000 miles, so that it may be in advance of the nucleus and again rest on its orbit. This orbit is an impassable line, and therefore instantly arrests the prodigious lateral velocity of the tail. That impassable orbital line is to it as solid and inflexible as a wall of adamant. The motion so instantly arrested would be disastrous to any tail, whether composed of gas, meteorites, or electricity, whatever that may be.

Having shown that the common theory of comets is filled with insuperable difficulties, I will again call attention to a theory proposed about eighteen months ago in the SCIENTIFIC AMERICAN.

According to this theory, a comet consists of a nucleus and an atmosphere, for the most part invisible, surrounding it on all sides to an extent at least equal to the length of the tail. The rays of the sun in passing through or near the nucleus are so modified as to become visible in their further progress through the cometic atmosphere, while all the rest remain invisible. What we call the tail is merely a radius of the cometic atmosphere made visible, and as the comet moves through space, only different portions of the atmosphere come in sight, in obedience to the ordinary laws of light. There is no difficulty in accounting for the rise and fall of the tail at perihelion, nor for the tail preceding the nucleus afterward.

The spherical theory accounts easily for the different forms of tail seen in different comets. The sword shaped tails, at variance with the common theory, can be accounted for by supposing a slight difference in density or material in the cometic atmosphere, which will deflect the light as seen. The comet of 1823, which cannot be explained on the common theory, is very easily explained on the spherical. That comet showed two tails, apparently of equal length, which moved opposite to each other, and perpendicularly to the orbit of the nucleus, and showing no signs of repulsive force from the sun. On the spherical theory it is only necessary to suppose such an arrangement of the nucleus as would reflect the rays of the sun laterally; a slight modification of the nucleus would give not only two but any number of tails pointing in different directions.

It may be objected to the spherical theory that a tail 50,000,000 miles long would call for a sphere 100,000,000 miles in diameter, and that would be too vast for our solar system. But it is claimed for this sphere that it consists of the same material as the so-called tail, and that it has the same capability of moving among planets without manifest disturbance to either.

The sphere at the perihelion would envelop the sun, and as a noticeable reduction is sometimes found in its so-called tail, the cometic atmosphere may impart to the sun at that time whatever is necessary to its use.

That there is something in common between the sun's corona and cometary matter was shown by the last solar eclipse observed in South Pacific Ocean, where the spectrum of sun's corona was found to be the same as that of a comet's tail. Are we to attribute in any degree the different appearances of the sun's corona to the presence or absence of a comet at

its perihelion? At the eclipse of the sun seen in Upper Egypt two or three years ago, a comet was seen close to the sun, but I have seen no account of the appearance of the corona at that time.

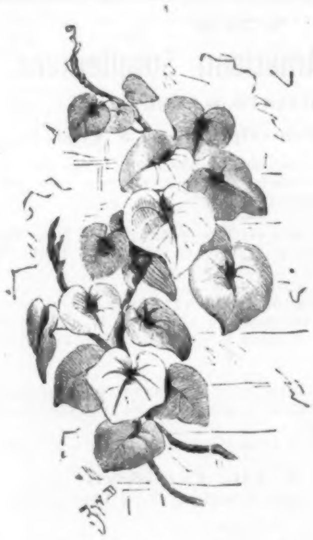
FURMAN LEAMING, M.D.

Romney, Tippecanoe Co., Indiana.

FORMS OF IVY.

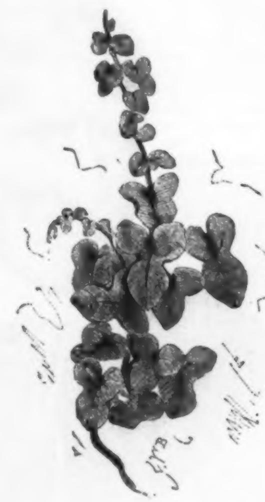
IT is scarcely possible for us to be too emphatic in our praises of the most distinct forms of ivy, since but few other hardy climbing plants ever give to us a tithe of their freshness and variety. A good long stretch of wall covered with a selection of the best green-leaved kind is always interesting, and never more so than during the winter months, especially if at intervals the golden Japanese jasmine is planted among them or a few plants of pyracantha or of Simmon's cotoneaster for the sake of their coral fruitage. The large-leaved golden ivy is also very effective here and there along a sunny wall, especially if contrasted with the small-leaved kind—atropurpurea—which has dark purple or bronzy foliage at this season. Of the large-leaved kinds, one of the most distinct is canariensis, or large-leaved Irish ivy, and Rægner's variety, with leathery, heart-shaped foliage, is also handsome. The birdsfoot ivy (pedata) is curious, as it clings to the stones like delicate leaf embroidery, and for shining green leafage but few equal the one called lucida. The two other kinds sketched are hastata and digitata, both free growing and distinct sorts.

Ivy Leaves.—Common ivy is tolerably plentiful nearly everywhere, but it is not common to find a good distinct series of its many varieties even in the best gardens. Of all the different forms of ivy, I think the large-leaved golden one of the best; certainly the best of the variegated kinds. Rægner's variety is also very bold, its great glossy, heart-shaped leaves most effective. Algeriensis is another fine-leaved kind, the form dentata producing foliage even still larger when well grown. For making low evergreen edgings on the turf, for carpeting banks, the covering of bare walls and the old tree stumps, we have no other evergreen shrub so fresh and variable, or so easily cultivated as are these forms of the ivy green. Perhaps one reason why the finer kinds of ivy are comparatively uncommon is the fact that a strong prejudice exists against ivy in many minds. It is an erroneous notion that ivy injures buildings against the walls of which it is planted; it never injures a good wall, nor a sound house, but, on the contrary, hides and softens the stony bareness of the one and adds beauty and freshness to the other.—*The Garden.*



Heart-leaved Ivy (Hedera Rægneriana).

Glossy Ivy (H. lucida).



Arrow leaved Ivy (H. hastata).

Finger-leaved Ivy (H. digitata).

Irish Ivy (H. canariensis)

Bird's foot Ivy (H. pedata)

VARIOUS FORMS OF IVY.

PROPAGATING ROSES.

IN an article on this subject an English horticultural journal describes the method pursued by a London florist. After stating that out of a case containing 310 cuttings only five failed to root, the article proceeds: The case or box is made of common rough deal boards. It is five feet six inches long and one foot in depth. Within half an inch of the top a groove is cut inside the box, into which the glass is slid, after the manner of a sliding box lid. In the end of the third week in July the box was placed in the kitchen garden under the shadow of a high north wall; it was then about half filled with good turfy loam, to which had been added a little leaf mould and a good sprinkling of sharp sand. The soil was then pressed down very firmly (the box being nearly half full when pressed), and then thoroughly well soaked with rain water, and allowed to stay uncovered until the next day. The next day good stout cuttings were taken of all the roses, both tea and hybrid perpetual, which it was desired to add to the stock. They were then inserted closely and firmly in the soil, just over the bottom leaf, the glasses were slipped on and puttied down; the grooves in which the glass slid, and even the joints in the glass, being filled with putty, so as to exclude the air. The whole thing completed, nothing more remained to be done but to leave the box in its cool, shady nook for five or six weeks, when the growing points of the free starting kinds gave notice that the glasses might be removed, a bit at a time, with safety. Nothing could be more simple, or demand less skill, and the operation may be carried out successfully by an amateur at any time during the season, when good firm cuttings can be got, and when six weeks' tolerably fine weather may be counted on. The success of the whole thing depends on having the glasses fixed so that they may not be removed until the cuttings are rooted, and in placing the boxes in a shady place. So treated, carnations and many of our shrubs and herbaceous perennials may be propagated by unskilled persons with certainty, and without much trouble.

A FEW OF THE BEST INULAS.

OF the fifty-six species of Inula described in scientific works, probably not more than thirty are at present in cultivation in this country, and those are chiefly confined to botanic gardens, notwithstanding the fact that many of them are useful garden plants. They are principally distributed throughout Southern Europe, although we find them extending to Siberia and the Himalayas; indeed, it is to the Himalayas we are indebted for the kinds that are most ornamental. Some of the low-growing species are extremely useful for the rockery, such as I. montana (the Mountain Inula), a fine dwarf plant with woolly lanceolate leaves and dense heads of orange-colored flowers, resembling in habit and general appearance some of the creeping Hieraciums. It is a handsome and desirable plant for the decoration of old walls and similar places, where it can be a little sheltered from rain and drip. Another very useful species for this purpose is I. rhizocephaloides, found plentifully in the Himalayas. It is one of the prettiest Alpine composites we have. It seldom attains more than from one inch to two inches in height, forming a dense rosette of short, hairy, oval leaves, in the center of which the bright purple involucres, in the form of a ball, are extremely interesting. It is easily cultivated, requiring, however, a rather snug nook, where it will not be allowed to become too dry. It is best propagated from seed. Then there is the woolly Inula (I. candida), a pretty plant with small oval leaves, covered with a thick, silky down, and much in the way of the white-leaved I. limonifolia, both of which are very effective when grown in masses, which should always be low down near the front of a rockery, or as an edging for a mixed border. The glandular-leaved Inula (I. glandulosa), of which a good representation is here given, is a beautiful hardy perennial. It is a native of Georgia and the Caucasian Alps, near the Caspian Sea. It is a rather robust-growing species, with large, bright, orange-yellow flowers, varying from three to five inches in diameter, the narrow and very straggly ray florets contrasting nicely with the rather prominent disk. The leaves, although quite entire, seem notched, owing to large black glands which form on their margins. They are lanceolate, and clasp the stem. The plant is very variable, both as regards robustness and size of flowers, and this may in a measure account for the confusion existing between it and I. Oculus-Christi.

The soil most suitable for the full development of I. glandulosa is a strong, clayey, retentive loam; it does not thrive well in the light shallow soils in the neighborhood of London, except in shady positions. I. Hookeri is a free-flowering perennial, with pointed lanceolate leaves, of a delicate texture, bright green, and very finely toothed. The flowers, which are sweet-scented, are not so large as those of I. glandulosa, and are produced singly, the ray florets being, however, much more numerous, rarely numbering less than thirty. It is found in abundance in rocky places in Sikkim, where it replaces the nearly allied I. grandiflora, a

INULA GLANDULOSA (*flowers deep yellow.*)

dwarfer species, with much shorter, shining leaves; both are very desirable plants either for rockery or flower border work. The Elecampane (I. Helenium) is an imposing, robust-growing species, having large, broad leaves a foot or more in length. It grows from four feet to five feet in height, and its thick, shaggy branches are crowned with large yellow flowers. For isolating in woods this plant is very useful, and with the exception of Telekia cordifolia, it would be hard to find a rival to it. It is, I believe, pretty extensively used for planting in shrubberies, but unless they are thin and open it is seldom seen to advantage. It is found wild or naturalized in some parts of England. It flowers in June and July, and even into August when the season has been favorable.

For naturalizing in woods the following will be found useful, *viz.*, I. salicina, I. Oculus-Christi, I. squarrosa, I. britannica, and many more, the true beauty of which can only be realized in this way. With the exception of I. rhizocephaloides, they are all propagated by division with the greatest ease, or by seed, which is best sown as soon as it is ripe.—*D. K., The Garden.*

FRUIT GROWING.

By P. H. FOSTER.

IN the first place, if you contemplate appropriating a portion of your land for the raising of fruits, you should have the orchard so situated that no large animals can run at large on the grounds. Prepare your soil in the most thorough manner; underdrain, if necessary, to carry off surplus water; dig deep, large holes; fill in the bottom with debris; in the very bottom put a few leaves, clam and oyster shells, etc., then sods; above and below the roots put a good garden or field soil; do not give the trees fresh manure at the time of setting, but the following fall manure highly with any kind on top of the ground; dig it in the following spring; keep the soil frequently worked during the summer, and, if convenient, mulch with hay, straw, or leaves.

Now you are on the road to progress, provided you have made no mistake in the selection of your trees. The purposes for which you intend your fruit is highly important. You should well consider at the outset if for family or market use. This is a business which requires a long look ahead, for it is said, "He who plants pears looks ahead for his heirs."

Caution should be used in procuring your stock; little should be planted that is not fairly tested on the Island,

purchased of parties who can be fully relied upon to give you what you want. Do not buy your stock of parties who carry labels in their pockets to make to order what you want out of the same bundle of trees.

Now, having your trees set out in a proper manner, of such varieties as you desire, the next important step is to bring the trees into usefulness. My plan is to use bone—fine bone—very freely about every three years. Another important matter is that of trimming. "Fire purifies," and the knife regulates the grand balance or equilibrium between roots and tops. In most cases the top outgrows the roots, the consequence of which is an ultimate weakness of the tree. It is thrown into excessive fruiting, disease, and premature decay. To avoid this result, use the knife when required. Thin out the inside branches when small, and if the tree does not make a satisfactory growth, cut back half way to the ground.

We will suppose that you have got your trees growing nicely, and they have begun to bear fruit. There are other important steps to be taken, which will be of little cost to you. Provide a wind-break for the orchard, Evergreens answer the purpose, being a protection against the wind. Having this matter attended to, there are other enemies with which we must contend. I refer to the apple and peach tree borers. The former will live in the tree for three years, if unmolested; the latter, one year only. They are very easily destroyed by looking over the trees and taking them out with a knife; or may be prevented from touching the trees by wrapping a piece of felt paper, 8 inches wide, around the tree near the ground, the bottom being covered with dirt and the top tied tightly above. The pear is not generally disturbed by these insects—only the apple, peach, and quince. We have another insect very destructive to the plum, peach, cherry, and apple—the *curculio*, or plum weavel. This season for the first time in twenty years we have gathered a small crop of that very desirable plum, the Purple Favorite. We simply threw air-slaked lime over the trees nearly every morning for from four to six weeks, from the time the tree was out of bloom. Peach trees should be treated in the same manner. Another method of fighting this insect is to spread a sheet under the tree, and with a blow jar off the little Turk and secure him on the sheet. But I consider the lime procedure the less trouble and more effective. The tent caterpillar, which is easily seen, should be destroyed at once. We have yet another insect to contend with which infests the apple and pear, commonly called the Coddling Moth, and the larva, the apple-worm (*Carpocapsa pomonella*). The loss by the ravages of this insect alone to the fruit growers of the United States can hardly be estimated, as in many cases the whole crop is rendered worthless. Such a vast destruction of two of the most valuable fruits the world produces should stimulate scientists in this age of progress to discover an effectual remedy against such a gigantic evil.

I have never yet discovered nor tried an effectual remedy against this insect. The nearest I have approached his extermination is in the following manner: After it has entered the fruit and accomplished its damage, the time arrives when it has to leave the fruit and hide itself in a quiet, secure position to undergo the transition from the larva to the pupa state, which requires, in the early part of the season, eight or ten days; after this time the miller is hatched and is again ready to besiege the fruit with its sting. The insect, being two-brooded in this climate at least, if not disturbed, has an aggregating force to do mischief the second time. The progeny for the succeeding year have alone to depend on the security of this second generation of larvæ. As they may often be found in bark of apple trees during winter, my plan of destruction is, about the first of July to take woolen rags long enough to wrap around the trees, and say four inches wide. Each week I look over the trees, and destroy the worms secreted under the rags and wherever I find them until the fruit is off the trees. I have all the green fruit, of every kind, carefully picked up as soon as it falls, thereby destroying many of the curculio as well as the apple-worms.

One word upon the grape—the insect part of the question. The *Phylloxera vastatrix*, or grape-vine louse, is already at work on Long Island. It is found very difficult to raise many of our fine, new grapes with us in consequence of the depredations of this very minute insect, it being almost too small to be seen by the naked eye. There has lately been discovered a remedy which is entirely chemical and as yet but little disseminated. Very soon, no doubt, a discovery will be made that will stay the progress of this destructive enemy.

We should plant a plenty of cherry and small fruit trees to yield feed for birds. In return they will assist us in our efforts to preserve a bountiful supply of this health producing element.

COARSE FOOD FOR PIGS.

A RECENT subscriber wants advice how to feed pigs of 25 to 35 pounds weight, that are to be kept over winter and fitted for sale at about six months old—whether coarse food will not help them as much in winter as in summer. How roots and pumpkins will answer in lieu of grass, and what can be fed when this green food is gone? He has had poor success in growing young pigs on corn alone. He has a reasonably warm pen for winter.

The question of food is constantly recurring, and this is one of the best evidences of the advancement of the country in the feeder's art. When people are making no inquiry as to improved methods in any direction, no progress can be made. There has been more progress made in the philosophy of feeding during the last thirty years than in the century and a half previous.

In pig feeding in the dairy districts, young pigs generally grow up in a very healthy condition, owing to the refuse milk of the dairy, which furnishes the principal food of young pigs. Skim-milk contains all the elements for growing the muscles and bones of young pigs. This gave them a good, rangy frame, and, when desired, could be fed into 400 or 500 pounds weight. But the fault attending this feeding was, that it was too scanty to produce such rapid growth as is desired. It took too long to develop them for the best profit. It had not then been discovered by the farmer that it costs less to put the first hundred pounds on the pig than the second, and less for the second than the third, etc.; that it was much cheaper to produce 200 pounds of pork in six months than in nine and twelve months. When it became evident that profit required more rapid feeding, then they began to ply them continually with the most concentrated food—corn meal or clear corn. If this was fed in summer, on pasture, no harm was observed, for the grass gave bulk in the stomach, and the pigs were were healthy and made good progress. But if the young pigs were fed in pen in winter upon corn meal or clear corn, the result was quite different; this concentrated food produced feverish symptoms, and the pigs would lose their appetite for a few days, drinking only water, which, after a while, would relieve the stomach, and the pigs would eat vigorously again. Now, had they been fed a few quarts of turnips, carrots, beets, or pumpkins, to give bulk to the stomach, and separate the concentrated food, no harm would have come. This gives the gastric juice a free circulation through the contents of the stomach, the food is properly digested and applied to the needs of the body instead of causing fever by remaining in the stomach.—*Live Stock Journal.*

METE KINGI.

OUR engraving is a portrait of a familiar character in New Zealand, chief Mete Kingi, who recently died at the age of one hundred years. He was a fine specimen of the Maori race, the native New Zealanders, a branch of the Malayo-Polynesian family. The New Zealanders surpassed all other people in the art of tattooing, to which their chiefs gave especial attention. Mete Kingi, as our picture shows, was no exception. Tattooing on the face they termed *moko*. The men tattoo their faces, hips, and thighs; the women their upper lips; for this purpose charcoal made from kauri gum is chiefly used. It has the blue color when pricked into the skin, growing lighter in shade in the course of years. The

THE LATE MAORI CHIEF METE KINGI.

subject of our illustration embraced Christianity, and was much respected. Our engraving is from the *Illustrated Australian News.*

LAKE TAHOE.

SOME very interesting information by Prof. John Le Conte, is given in the *Overland Monthly*, being the result of some physical observations made by the author at Lake Tahoe, in 1873. Lake Tahoe, also called Lake Bigler, is situated at an altitude of 6,247 feet in the Sierra Nevada Mountains, partly in California, partly in Nevada. The lake has a length of 22 and a width of 12 miles. As regards its origin, the author regards it as a "plication hollow," or a trough produced by the formation of two mountain ridges, afterward modified by glacial agency. The depth of the lake is remarkable; the observations taken at ten stations along the length of the lake gave the following depths in feet: 900, 1,385, 1,495, 1,500, 1,506, 1,540, 1.504, 1 600, 1,640, 1645. This depth exceeds that of the Swiss lakes proper—Lake Geneva, for example, has a maximum depth of 1,096 feet—but is considerably less than that of Lakes Maggiore and Como, on the Italian side of the Alps. A series of observations of the temperature of the water were taken between the 11th and 18th of August. The average corrected results are as follows:

Depth in feet.	Temp. (C.)
0 (surface)	19·4
50	17·2
100	12 8
150	10·0
200	8·9
250	8·3
300	7·8
330 (bottom)	7·5
400	7·2
480 (bottom)	6·9
500	6·7
600	6·1
772 (bottom)	5·0
1506 (bottom)	4·0

The temperature, therefore, diminishes with increasing depth to about 700 or 800 feet, and below this remains sensibly the same down to 1,506 feet; or in other words, a constant temperature of 4° C. prevails at all depths below about 820 feet. This is in accordance with the theory, the temperature named being that of the maximum density of water, and it confirms the recent observations of Prof. Forel in Switzerland; he found, for example, that a constant temperature of 4° C. was reached in Lake Zurich at a depth of nearly 400 feet, the lake being then covered with 4 inches of ice. The explanation of the observed fact that Lake Tahoe does not entirely freeze over even in severe winters is found in the extreme depth; and the fact that the bodies of drowned persons do not rise to the surface after the lapse of the usual time is explained by the low temperature prevailing near the bottom, which does not allow the necessary decomposition to go forward so as to produce the ordinary result.

The water of Lake Tahoe is remarkable both for its transparency and beauty of color. A series of observations made at the close of August or beginning of September showed that a horizontally adjusted dinner plate of about 9½ inches diameter was visible at noon at a depth of 108 feet. The maximum depth of the limit of visibility as found by Prof. Forel, in Lake Geneva, was 56 feet. He showed, moreover, that this limit is much greater in winter than in summer, as explained in part by the greater absence of suspended matter and in part by the fact that increase of temperature increases the absorbing power of water for light. The maximum depth of visibility in the Atlantic Ocean, as found by Count de Pourtales, was 162 feet, and Prof. Le Conte states his belief that winter observations in Lake Tahoe would place the limit at even a greater depth than this. The author gives a detailed and interesting discussion in regard to the blue color of lake waters, reviewing in full the results of previous writers on the subject, and concludes that while pure water unquestionably absorbs a larger part of the red end of the spectrum, and hence appears blue by transmitted light, the color seen by diffuse reflection is mainly due to the selective reflection from the fine particles suspended in it.

The last subject discussed by the author is that of the rhythmical variations of level, or "seiches," of deep lakes; he applies the usual formula to Lake Tahoe, and calculates from it the length of a complete longitudinal and of a transverse "seiche;" these are found to be eighteen or nineteen minutes in the first case and thirteen minutes in the second.

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